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COMBINED DIRECT AND ALTERNATING-CURRENT RAILWAY EQUIPMENT.

The ability of the new types of single-phase series motors to adapt themselves to severe service requirements is well illustrated in the equipment now being installed betwen Indianapolis and Cincinnati. The demands of existing roads usually necessitate that all cars passing through a city shall be capable of using the tracks already laid, and it seems imperative that a single trolley wire shall supply current to either the new or the old motor equipments, thus the use of direct-current throughout some portion of the route appears to be unavoidable. The time has not yet arrived when a trolley voltage sufficiently high for economical transmission over great distances will be permitted above the city streets, and, therefore, two working voltages are in most cases indicated for combined urban and interurban service. In spite of the difficulties thus attending the application of high-voltage alternating-current to urban work, the economical advantages in comparison with low-voltage direct current for interurban service have led to the introduction of a type of motor and system of control which are advocated as meeting all requirements.

As is well known, the motor is of the conductively-compensated, series-wound type, and practically operates equally well whether fed with direct or alternating current. In this issue we are enabled to give a complete diagram and a description of the controlling circuits involved. The main features of the mechanism are in conformity to standard Westinghouse practice, and involve the use of compressed air as an agent in operating the switches for controlling the motor circuits, while the valves for the air itself are placed in service as required by means of electromagnets energized by current from a storage battery. The relatively novel features reside in the method of electrically interconnecting the main motor circuits to conform to the nature of the supply current. For the induction regulator, which can be used only with alternating current, has been substituted the less economical but equally effective rheostat, in order to satisfy the exacting requirements of the direct current, while the series-paralleling of the motors, so common in direct-current service, has been omitted, plain series connection being used for direct and plain parallel for alternating current, for sake of the simplicity of the controlling mechanism and the lack of need of control refinements for the limited use to be made of direct current.

THE ELECTRIC DRIVE.

The developments of the past several years have clearly established that the electrical method of distribution of power has become an essential feature of modern shop equipment, the aim of which is intensive and economic production. The time-honored method of power distribution by line shafting from a distant prime mover, while fairly effective for certain classes of work, is so lacking in flexibility and general adaptability to the ever-increasing requirements of the modern shop and factory, as to be now disregarded in the consideration of new installations, and is, moreover, being rapidly replaced by systems of motor driving in many of the more progressive older plants. The motor drive, in replacing the line shaft, removes from the shop the limitations of power and speed at the tools driven, removes the dirt, noise and ever-present danger to workmen who must necessarily work in close proximity to the belts, permits a clean, light and workable condition of shop to be maintained, and, above all, permits of the most convenient

and accessible arrangement of the individual machines with respect to the work in hand and the order of its progress through the shop. In fact, before the introduction of the motor drive very little was known of the real effect which the shortcomings of the line-shaft method of driving had upon the production factor of a manufacturing establishment.

It is interesting to note that, while the use of the motor drive was at first thought to be of value merely in economy of power through removing the extravagant wastes in friction in the line shafting, a higher economy has been found to lie in its remarkable effect upon the production factor of a shop. The percentage which the cost of power, in the average manufacturing shop, enters into the total cost of the finished product varies from 2 to 5 per cent., the labor cost being the important factor in manufacturing, and amounting usually to upwards of one-half the total cost of the product. The application of the electric motor to individual machines and for driving in groups naturally results in greater reliability and effectiveness of operation. Each machine or group of machines is rendered entirely independent of all others in the shop, and yet at all times, either day or night, is fully as effective as though connected direct to the prime mover; a better control of the machines is thus secured, which naturally is very favorable to economical operation. The advantages above enumerated must have an important effect upon the rate of production of the tools, and it is therefore not surprising that the experience of manufacturers has revealed a greatly increased output from the adoption of the electric drive.

There is still a diversity of opinion as to the relative advantages of the so-called "individual" and "group driving." The latest developments indicate a tendency toward the use of both the group and individual methods, it being very generally agreed that the larger tools should be equipped with individual motors, preferably of the variable-speed type. In very many shops the use of individual drives is being extended to smaller tools as well as to the large ones, it being thought that the advantages of greater production should be obtained from the smaller tools as well as from the larger ones; and, furthermore, that the advantages of the flexibility and portability incident to the individual drive are of great value in the case of every tool. On the other hand, others offer the objection that the multiplication of small motors means increased complication and greatly increased investment. The first cost is, of course, greater, but neither the matter of complication nor of maintenance has proven serious in practice. The best practice of the country in this line would certainly seem to indicate that a reasonable amount of individual driving is warranted even in the face of all the objections that have been raised. The question of variable-speed driving is also still unsettled, but it is held by many that this is one of the prime sources of advantage of the individual drive in machine tool work. Many of the machine tools, such as lathes, boring mills, milling machines, etc., actually demand wide variations of speed for the best results, while other types operate to better advantage with a variable speed drive. Whatever the final verdict on the questions yet open, it has been clearly demonstrated that in every case much gain in shop practice is offered by the electric drive, and in many establishments important savings in the way of greatly increased production with no change in labor cost has resulted from its adoption.

THE ERA OF THE ELECTRIC MOTOR.

In bringing prominently before the public the motor drive for machine tools and various industrial purposes, we are doing something more than showing the wonderful growth of electrical developments. We are bringing before men's eyes new forces that make for civilization and the betterment of society. The improvements that make manufacture more facile, and reduce the average waste of energy directly or indirectly, tend to lighten the burdens of humanity. And in particular the wholesale substitution of electric motors for other sources of power awakens the hope that men may yet see more clearly the large importance of electric power in checking the terrible waste of fuel that daily increases, and in obviating some of its most serious concomitants. We are not alarmists on the coal question. There is certainly fuel in existence for centuries to come even at the present lavish rate of expenditure. The coal measures have been touched only in a very small part of the earth's crust, and who can tell what boundless wealth may exist in the inhospitable hyperborean regions or underlie the tropical wilds of South America and the lonely jungles of that vast African continent that is to be the scene of the world's enterprise in the next few centuries. Exhaustion of fuel is not the question. Anthracite, to be sure, is relatively near to its end, so that those of us who have not yet passed Osler's dead line may very probably live to see it a rarity like cannel coal, even if not a mere mineralogical curiosity. But centuries before coal becomes actually rare it will become prohibitively high in price so far as our present methods of use are concerned. It takes but a few hundred miles of transportation even now to put coal to an exhorbitant figure, and even before we have to deal with the Nyanza Coal Syndicate, Limited, the case will be serious.

It is against this unpleasant situation that the present activity in electric motor work gives us hope. When people are fairly educated up to the general use of electric motors for their own sake, it is not difficult for them to grasp the importance of a general distribution of power to motors. Such enterprises as the Yorkshire and Lancashire power distribution schemes, of which we have more than once made mention in these columns, give promise of an era in which fuel will be utilized in the most economical way to bring an ideal motive power to the door of every factory. Up to the present time there has been no really serious attempt to burn coal at the very mouth of the mine, and to send its transformed energy over the wires for the use of all men. In the first place, there has been hesitation at the distances involved in the transmission, and, in the second place the market has been uncertain. Now there seems to be definite understanding of the fact that a motor drive is a useful and economical thing of and in itself, so that the old-fashioned tendency to fall back on a local prime mover is now greatly weakened. This comprehension opens the way for using fuel economically upon a gigantic scale, saving much fuel of a grade now wasted and utilizing the rest to the best possible advantage. It has also now been shown that granting a general use of motors, power can be distributed over a huge network at a very economical rate, so that a great region instead of a long strip can be efficiently served. Of course, where water power can be used to advantage, the case is better yet, but quite apart from that it is plain that a general power service organized on a colossal scale can be made effective and profitable even at our present prices of fuel.

Every increase in fuel cost means added loss if the utilization is inefficient, and the increase required to drive that lesson home is by no means large. With steam coal at twice the present average price, small industries would be driven to motors or out of existence. There is still another phase of the subject that is of great and direct importance to the constantly increasing proportion of humanity that lives in cities. The increasing use of soft coal has steadily aggravated the smoke nuisance until it has become not only a source of serious inconvenience but of great and positive loss. City after city is protesting against the smoke that pours in black clouds from its chimneys. Of course, careful firing will do much

to help the matter, but it cannot do everything, and experience has shown that wherever much soft coal is burned the smoke nuisance is active. Now the remedy in the light of electrial science is clear. When the electric motor is pushed into general use the small steam plants disappear and are replaced by a few large ones which can, and in the end ought to, be located where the smoke they produce can do no harm. And fuel for heating should follow fuel for power. It should not be the mere shadow of a dream to imagine far away from a city, on waste land, a gigantic plant producing fuel gas enough to operate a group of central heating stations for the entire service of the city, and using its coke and waste heat to generate all the electricity needed for lighting and power. So constituted one plant could do the fuel burning for a million people, and the city air would be as fresh and clear as that from the mountains. Perhaps even electric heating could be advantageously used for all minor purposes. Certainly the path is now open toward the fulfillment of such a forecast. None of us may live to see it, but surely if mankind is determined to be concentrated in cities, the heavy hand of necessity will compel the regeneration of urban conditions. We are just beginning to appreciate the almost boundless future that lies before the electrical arts in their relation to humanity.

THE OSMIUM INCANDESCENT LAMP.

In the Digest will be fond an abstract of a very interesting paper on the Osmium lamp recently read before the Electrotechnischer Verein, of Germany. It is now generally admitted that the amount of radiant power emitted by a hot carbon filament is proportional to the fourth power of its absolute temperature. This is known as Stefan's law. Of course, surrounding bodies will simultaneously be engaged in radiating a certain amount of power back to the filament at a rate proportional to their absolute temperatures. The resultant power radiated from the filament will be the difference between the outgoing and incoming radiations. In order to emit luminous radiations, the temperature of the filament must be raised above that of red heat, and the luminous efficiency will be the ratio of the visible radiance to the total radiance. This efficiency, which is zero below dull red heat, increases above that temperature, and at the temperatures ordinarily attained in carbon filaments, is generally accepted to be from 1 to 0 per cent. If Stefan's law were universally true, then a given surface area of carbon, or of platinum, or of osmium, at a temperature of, say, 1,600° absolute would have the same luminous efficiency at ordinary room temperature, and the only advantage that could accrue to a change of substance would either be mechanical, as to strength in filamentary form, or as to durability at high temperatures. That substance would have the advantage which, at the highest temperature, could last a reasonable time, say, 800 hours. It has until recently been a generally accepted belief that carbon was the substance which could endure a higher temperature than all others. The highest commercial output that the carbon incandescent lamp has given in practice is is approximately one-third candle per watt, corresponding to a specific consumption of about 3 watts per candle. Nevertheless, if the efficiency of a glow-lamp could be raised to 100 per cent. we might expect about 8 candles per watt, or, say, 375 16cp. lamps per electrical horse-power.

In recent years the German chemists have been seeking for metals that would endure a higher temperature than carbon, and thus raise the luminous efficiency. Of the rare metals in this way selected have been osmium and tantalum. Both are heavy metals, and both have hitherto been regarded as objects of rare curiosity, suitable only for museums, and unsuitable for any practical purpose. Both have been known for about a hundred years, having been independently discovered about the beginning of the last century. Not only do osmium and tantalum endure a higher temperature than carbon or platinum, but they also seem to be more efficient as luminous radiators for a given temperature; that is to say, they appear to deviate in the desired direction from Stefan's law. Stefan's law is admitted to be restricted to so-called black bodies. In a polished body, or non-black body, the condition of the surface is shown by its optical properties to differ markedly in regard to radiant energy relations from a black body. Possibly the molecular freedom of oscillation is greater in black surfaces. However, the luminous efficiency of a bright surface appears to be much superior to that of a black surface. For this reason also it is claimed that a metallic filament is more efficient than a carbon filament. Up to the present time, many thousands of osmium lamps are stated to have been manufactured in Germany. They have all been of very low voltage. Most of them have been of 37 volts and 25 hefners, equivalent to 22 cp. Three such lamps are adapted to burn in series on a 110-volt circuit. The length of the filament of these lamps is nearly one foot (280 mm), so that a 110-volt filament of the same diameter would be nearly a yard long. It is stated, however, that the limits of voltage have been steadily rising with increasing experience, and that 110-volt osmium lamps are likely to be realized. The specific consumption of these lamps is given as 1½ watts per candle, with a lesser susceptibility to change of candle-power with change of voltage, and with a probable lifetime of several thousand hours. The candle-power rises during the first 250 hours, and then falls off steadily, but more slowly than the carbon lamp, the diminution being less than 20 per cent. in 2,000 hours.

The fact that both tantalum and osmium lamps are now on the market in Germany at reasonable rates, with a consumption of less than 2 watts per candle, suggests the possibility of ultimately bidding farewell to the carbon lamp. Whether this result actually comes about will, of course, depend upon a variety of practical and commercial considerations. But if 2 watts per cande can be attained with long life and no great increase in cost, it is manifest that the carbon lamp must either be made to consume less than 3 watts per candle or disappear. It was thought at first that osmium was so scarce a substance that the demand for incandescent lamps could not be commercially met. A pound of the metal would, however probably suffice to make many thousands of filaments, and even if osmium were as costly to procure as gold or platinum, the cost of the metal in a single filament would not be excessive. Moreover, no serious attempt has, perhaps, been made to procure any quantities of osmium prior to its recent development for incandescent lamp filaments. Assuming the most favorable alleged conditions for the osmium or tantalum lamps—that their lifetime is long, their first cost not immoderate and their specific consumption as low as 1.5 watts per candle—then the effect of the gradual replacement of carbon lamps by metallic lamps would practically halve the consumption of energy for the same amount of lighting. Likewise, the income derived from incandescent lighting on the kilowatt-hour basis of meter records would be cut in half for the same amount of light supplied and for the same cost of electric power. At first sight this might seem to be an exclusive gain for the customer, at the expense of the central station. But unless the change were made very swiftly, the benefit to the consumer would not be a blow to the electric lighting industry. The central station would be able to connect twice as many lamps and customers, without increasing the cost of the plant, and would be able to sell the lamp-hour at half the present cost, while retaining the present price of the kilowatt-hour. With cheapened electric light, the growth of electric lighting would be stimuated, so that eventually everyone would participate to some extent in the saving of power effected by a more economical filament. We can only hope therefore that all the expectations from osmium and tantalum may be realized.

Telephonic Investigation in New York City.

The Merchants' Association of New York City has issued the following statement as to its investigation aimed at learning whether or not the present telephone charges in New York City are just and reasonable, and with the further purpose of taking such action as might be necessary to secure a proper reduction in case it was found that the charges were unjust. The report says: "At the outset a stipulation was entered into with the officials of the New York Telephone Company whereby they agreed to afford the committee of the Merchants' Association all reasonable and proper assistance in the inquiry proposed. The committee proceeded to make an exhaustive examination into the telephone charges of other cities as a basis of comparison, and also accumulated a large body of data relating to the necessary cost of construction and operation of telephone service in various cities. Incidental to this inquiry it had the benefit of the expert advice of Messrs. Westinghouse, Church, Kerr & Company, a firm of electrical engineers of international reputation, and the immediate services of Mr. A. V. Abbott, for nine years chief engineer of the Chicago Telephone Company, and one of the foremost telephone engineers of the day.

"After accumulating these general data, the committee availed itself of the offer of the New York Telephone Company and entered upon an examination of the investment, equipment and operating accounts of that company, and of its gross and net earnings, with a view to determining the reasonableness of the charges for telephone service in this city. The committee was afforded by the telephone company every reasonable facility for making the examination desired, and was further authorized to verify the statements submitted to it relative to the accounts of the company, through a firm of public accountants of highest standing and of our own selection, in order that the latter might give a certificate of the accuracy of the accounts so inspected.

"At an early stage of its negotiations, the committee reached an agreement with the telephone company as to the percentage of profit which would be considered fair, and its further investigations have been directed to ascertaining what the actual profits of the telephone company are, with a view to their reduction to the agreed percentage, if found materially to exceed the figures agreed upon. The examination is not yet complete, but is still in active progress. The results thus far obtained are entirely satisfactory to the committee, and it is the conviction of the committee that the final results of its work will be satisfactory to the public as well."

In view of these facts, President Clarence Whitman expresses the decided opinion that the proposed legislative investigation of the same subject is quite uncalled for and unnecessary.

The Electrical Fire Hazard.

Mr. W. T. Benallack, special agent and electrician for the Western Factory Insurance Association, presented a paper on the electrical fire hazard at the meeting of the Electrical Section of the Western Society of Engineers in Chicago, March 10. Mr. Benallack's paper, after pointing out the advance in the art of electric wiring and in the corresponding art of precautions to prevent defective wiring, enumerated some of the principal causes of electric fires. In the latter part of his paper he called attention to the need, not only of uniform rules which we now have, but also uniformity in the interpretation of rules by inspectors. It is an unfortunate fact that the difference in the way various inspectors interpret rules virtually makes considerable difference in the requirements in various localities. The associtions of electrical inspectors which had been formed would be a good thing and would tend to eradicate this defect.

In the discussion, Mr. Harold Almert called attention to one matter of detail which he thought ought to be more definitely covered in the National Electrical Code. This was the exposed live portion of an Edison lamp base. This live portion in some causes, he said, extended one-half inch below the socket. He cited one case where a very uncomfortable shock had been received by the customer of a central station company who got hold of this live, exposed portion of the lamp base on a socket while attempting to turn on a lamp, with his body in contact with a radiator. The circuit being 115 volts alternating and grounded on one side, this man had received the full 115 volts, which, while not dangerous, was decidedly uncomfortable. This live, exposed part of the base, he should think, might easily cause electrical fires.

Mr. J. R. Cravath endorsed earnestly what Mr. Almert had to say about the need of some attention being paid to the exposure of the Edison lamp base. Elaborate rules had been drawn up regarding the construction of sockets and their linings, but nothing was said about an exposed lamp base just below the socket, which frequently was a source of danger and discomfort. He also urged a campaign of education among the smaller electric lighting companies as to the importance of grounding secondary circuits connected to interior wiring, as it was absolutely the only way to safeguard life and property, and this fact was not as much appreciated by the smaller electric lighting companies as it should be.

Mr. Benallack said that this matter of the exposed lamp base had been taken up with lamp manufacturing companies and there had been much improvement. Some manufacturers now make lamp bases which do not extend beyond the socket.

Other speakers also called attention to the importance of grounding secondary circuits as a good way, and, in fact, the only known way to make these circuits safe against leakage of current from the primary circuit. The underwriters had been slow to permit this at first and it was largely due to the central station men, who appreciated the practical dangers, that the practice was first permitted and finally positively recommended by the underwriters. Another indirect fire hazard caused by electricity was due to the firemen's fear of high-tension pole lines in front of high buildings. Some very unfortunate accidents have occurred which make the firemen give these wires a very wide berth, as they were justified in doing. This in itself amounted to introducing an additional fire hazard.

Philadelphia A. I. E. E. Meeting.

At the regular meeting of the Philadelphia Branch of the American Institute of Electrical Engineers, held March 13 at the rooms of the Engineers' Club of that city, Mr. E. P. Coles presented in abstract and discussed the paper read at the February New York meeting by Mr. N. McD. Crawford, on "Two-Motor vs. Four-Motor Equipments," and Mr. H. F. Sanville presented and discussed Mr. C. W. Ricker's paper on "Track Bonding." Mr. William McClellan showed a Duddell oscillograph and explained its principles. Mr. J. W. Kelly, Jr., of the Keystone Telephone Company, showed and explained a device recently developed by his company for recording the calls on measured service lines. This instrument is so arranged that the subscriber has before him at all times a register of the number of calls, and a check record is kept at the central office. It takes no account of "busy" or "don't answer" calls. Mr. Alexander Churchward presented a paper on the mercury arc rectifier, which apparatus was shown in actual operation.

Indiana Union Traction and Allied Companies' Annual Meeting.

The annual meeting of the Indiana Union Traction Company, the Union Traction Company, of Indiana, and the Indianapolis Traction Company, was held in the general offices in Anderson, March 7. The report covers the allied companies as a whole. The current receipts from all sources for the year 1904 were $1,341,236; operating expenses, $731,328; net income, $609,907; fixed charges, including dividends upon annexed property, stock, dividends and rentals, $591,453; surplus for the year, $18,454. The report stated that the increase in earnings of 1904 over that of 1903 was nearly $325,000, during which time the lines of the Indianapolis Northern Traction Company were completed. The matter of building an immense central car shop in Anderson was discussed and the final arrangements deferred until the meeting which is to be held in Philadelphia. The stockholders elected the following board of directors for the Indiana Union Traction Company and the Indianapolis Northern Traction Company: George F. McCulloch, of Muncie; Randall Morgan, J. Levering Jones, Henry H. Kingston and J. A. Harris, of Philadelphia; W. Kelsey Schoepf, of Cincinnati, and A. W. Brady, of Anderson; and the stockholders of the Union Traction Company of Indiana elected the following directors: Hugh J. McGowan, Indianapolis; Philip

Matter, Marion; J. Levering Jones, Philadelphia; Ellis C. Carpenter, W. C. Sampson, Jas. Van Osdal and Arthur W. Brady, of Anderson. The board organized and elected for president, Philip Matter; vice-president, E. C. Carpenter; secretary and treasurer, W. C. Sampson. The former boards will organize at the Philadelphia meeting next week.

Legal Status of Grounding Secondaries.

The legal side of the subject of grounding secondaries of electric lighting systems recently received consideration in a suit resulting from the death by electric shock, the case being that of Witmer vs. the Buffalo & Niagara Falls Electric Light & Power Company, recently tried in Lockport, N. Y.

The accident leading to the suit happened in the residence of Loren T. Witmer at Niagara Falls in the fall of 1903. The house wiring was installed in 1895 and was up to the standard of that date. The mains entered the second floor through an old-style Edison rotary snap switch with porcelain barrel and leaf copper contacts. The cellar light was controlled by a single-pole snap switch on the first floor and had a tell-tale light just above the switch to indicate when it was burning. The cellar floor is concrete and the light consisted of a brass key socket connected to a fusible rosette by about 10 ft. of silk flexible cord, which was usually suspended by a hook placed in the ceiling for the purpose.

The night of the accident was dry and windy. Mr. Witmer, who was sleeping on the first floor, was awakened by his wife, who had heard a loud buzzing noise, and had seen the cellar indicator light flash. He went, with bare feet, to the second floor and turned off the entrance switch and then to the cellar, his wife being with him. As he reached the cellar floor he picked up a part of the lamp cord which lay upon it and his wife turned back for a light, as they had been using matches. When she reached the head of the cellar stairs she heard a groan and fall and saw the cellar light flash. She then aroused the household, procured a lamp and going down found her husband lying lifeless at the foot of the stairs. The thumb and forefinger of one hand were deeply burned, and part of the insulation was burned from the cord. Physicians were called, but several hours' work failed to resuscitate him.

The widow afterward brought suit for $25,000 against the lighting company, and the case was tried in Supreme Court before Judge Kenifick. Messrs. Ackerson and Chapin, of Niagara Falls, appeared for the plaintiff with Montgomery H. Johnson, of Johnson & Morton, Utica, as electrical expert. Messrs. Poolley and Spratt represented the defendant, with Mr. H. P. Buck, of the Niagara Falls Power Company; Messrs. Gebbney & Sellers, of the Buffalo General Electric Company, and employees of the defendant company as experts.

The plaintiff's witnesses testified that the deceased had been in good health and died from electric shock of high voltage, the current having passed through two open switches, burned the flexible cord and his hands; that defendant had contracted to supply current for lighting at 104 volts; that primary wires carrying 2,200 volts, secondary wires for the building and an arc light wire for a constant-current alternating circuit with 100 arc lamps at between 7,000 and 8,000 volts were carried on the same cross arms, and in some places passed through trees; that on the night of the accident a cross occurred between this arc circuit and the fire alarm telegraph system of the city, and when the arc circuit was shut down the noise and flashing of lights ceased in the Witmer residence; that the secondary system was not permanently grounded and that a permanent ground connection would have prevented the dangerous voltage from entering the house; that the circumstances indicated the possibility of current from the arc circuit coming into the house upon the wires of the secondary system from some point where they came in direct contact, or both in contact with some conducting substance.

On this evidence the case was rested, counsel maintaining that the defendant must prove themselves free from negligence in permitting a state of affairs to exist that rendered the accident possible.

The defendant moved for non-suit as no negligence was shown, which the court denied. The defendant's witnesses testified that Witmer had signed a contract for lighting, expressly relieving the company from damage resulting therefrom; that shock from 100 volts had been known to be fatal and cause severe burns; that grounding overhead secondary systems was not usual practice, increased the risk to linemen, and danger of transformers breaking down from lightning and other causes; that at one pole of their system, the fire alarm wire which had been in trouble the night in question, passed along a cross arm from one side to the other and touched the cross arm bolt; that it was possible the current which killed Witmer was carried from the arc wire by the fire alarm wire to this pole, and from the cross arm bolt to the heart of the pole, thence down to the cross arm bolt next below, and to some twisted pairs of telephone wires which were run in such position that they could swing into contact with the secondary wires supplying the Witmer residence; that current sufficient to burn the switch contacts in the house, burn the insulation from the flexible cord and burn the hand of the deceased, could have passed in this manner without leaving any traces of burning either on the pole, cross arms, bolts or when passing from one insulated wire to another; that it was more possible that the current which caused the accident took the course just described than that it passed directly from the arc wire to the secondary, or by means of a tree branch touching both.

The defendant asked that the case be dismissed as they had shown the City of Niagara Falls to be responsible for the accident; that deceased had signed a contract releasing them from all liability; that deceased had shown contributory negligence in the use of an improper fixture in his cellar, and in handling the same when he knew it to be out of order.

This was denied and the court sent the case to the jury, charging them that if the theory advanced by the plaintiff that high-tension current was carried to the secondary directly from the arc wire, or by tree branches, then the defendant was negligent in not providing a permanent ground connection to the secondary system. If, on the other hand, the theory advanced by the defendant that current was carried by the fire alarm wire from the arc wire, via cross arm, bolts, pole wire and telephone wires to the secondary, then they were not guilty of negligence and could not recover.

The jury returned a verdict of $6,700 for the plaintiff and the case will probably be taken to the Appellate Division by the defendant. The case had proved of unusual interest as the questions involved have not heretofore been tested in New York State courts. The ruling of the court that the company was free from negligence if it could prove that a foreign wire caused the trouble is also considered rather unusual by those who followed the case carefully.

American Street Railway Data.

The Bureau of the Census has just published an exhaustive report on street and electric railways for the year ending June 30, 1902, prepared under the supervision of Mr. W. M. Steuart, chief statistician for manufactures.

In June, 1903, a preliminary report on this subject was issued in the form of a Census bulletin giving the principal statistics for all street and electric railways doing a public business in the United States.

The report just published contains, in addition to detailed statistics, more than two hundred pages of text prepared by two expert special agents, Mr. T. Commerford Martin, of New York City, and Mr. E. Dana Durand, of the Bureau of Corporations. This text discusses the development of the modern street railway system, the generation and distribution of electric current, car equipment, and a variety of other features upon which the technical efficiency and economy of the street railway service depend. It also treats of methods of installing and operating interurban systems, handling passengers, freight, mail, express, etc. Statistics are presented showing the growth of mileage and traffic, and the effect of development upon the distribution of the population.

Among the other subjects considered in this volume are capitalization, relation of expenditures to receipts, general financial results, terms of franchise, rates of fare, accidents, safety appliances, and the wages and conditions of labor. The value and interest of the report are increased by the introduction of maps and illustrations, the former showing the network of electric railways in Ohio and Indiana and the latter showing the appearance, development, and equipment of cars and stations. The early history of the art is also presented in its various aspects, and a large number of illustrations give added value to the report which is the first of its kind issued by any government.

New British Patent Office Rules.

By W. B. Vansize.

It may interest your readers to know that the British Patent Office has made radical changes in the proceedings following the filing of an application for letters patent, and that these changes cause the British Patent Office practice to more nearly resemble that of the United States, and, to a certain extent, of Germany.

Heretofore, as is well known, Great Britain has made no examination whatever as to the novelty or utility of an invention sought to be patented. An applicant was at liberty to file his application and the patent issued upon the payment of the fees as a matter of course. An applicant could file what is called a provisional application, briefly describing his invention, which might or might not be accompanied with a drawing, and then a period of nine months ensued for the presumable completion or perfection of the invention and the filing of a complete and illustrated description. Formal claims were not necessary, the courts being depended upon to distinguish, in case of a contest, between what the patent showed and described that was novel and useful and what could be proved to exist, as prior knowledge and use. This comparison by the court has often seemed to the writer a strong feature of merit, although the United States courts sometimes approximate very closely to the same practice if the claims are susceptible of the construction sought to be put upon them.

Since January 1, 1905, the new British law has become effective, the period of provisional protection above referred to has been shortened to six months, and an official examination as to novelty of all inventions described and claimed in complete specifications is now made. Where the provisional application was made before January 1, the period of provisional protection for that application will be nine months as heretofore, and no official search will be made as to the novelty of the invention.

The most important change is this official search as to novelty, which is made after the filing of the complete specifications. No examination is made as regards provisional specifications. The time allowed for replying to all official letters, as to the novelty of the invention, is two months instead of one year, as in the United States' practice; but in all cases amendments must be made, if desired, and complete specifications accepted, within twelve months after the date of application. The time for acceptance, however, could be extended for one, two and even three months, but no more, by payment of a fine amounting to about fifteen dollars for each month of extension applied for.

The Patent Office Examiners can only cite against an application, British patents bearing date not more than fifty years before the date of application upon which the search is being made, and if an applicant refuses to have his specification amended, so as to limit it to what he has actually invented in view of the cited British patents, letters patent will not be refused, but the British Commissioner of Patents may insert at the end of the claims list of the cited earlier patents, so that any one may know the exact situation and the position of the office regarding the claims.

A very important change in the practice is that when a complete specification as filed does not fully and sufficiently describe and explain the invention, the commissioner has power to cancel the original date of the application and to assign to the application a new date, as late as that upon which the amendment was made. It is thus now extremely necessary that the complete specification as filed should fully and completely describe and explain the invention, as otherwise the date of application may be lost and the prospective patent rendered invalid by reason of a possible publication in the time intervening between the attempted filing date and the date of amendment, which would be the actual date.

Then, again, it has been customary to make British patents a sort of omnibus, in which several inventions might be included; that is now a thing of the past. A British application must now be limited to a single invention, and there should be a few claims, clear and concise, without ambiguity and without unnecessary multiplication. For this additional labor, probably, the patent office charges a final fee of one pound. Where proceedings are taken under the International Convention—that is, where one is attempting to get credit in Great Britain for a date of application as early as that constituting his filing date in the United States—he must file a complete specification in the first instance, together with a certified copy of the specification as filed in the United States; and it is emphatically the better practice to file the complete specification in the first instance.

This amended British law has not been in effect long enough to enable any mature judgment to be formed in regard to it, but so far as the writer can forsee, it seems to be some improvement. At any rate, the British Government will not find itself in the position of issuing duplicate patents for the same invention within a period of fifty years.

Electricity for Railroads.

In a recent paper before the Iowa Railroad Club, Mr. S. Cass, president and general manager of the Waterloo, Cedar Falls & Northern Railroad Company, said: "For yard work on the Waterloo, Cedar Falls & Northern road the electric locomotive is not feasible, neither is it suitable for drawing heavy freight and passenger trains, as the heavy trains would overload the power house and no other cars would operate while they were being moved.

"One freight train would probably require the maximum output of the power house, and we would be burning coal and conveying the power for miles over a conductor at a great loss in transmission, when we can burn the coal on a locomotive right at the point of service just as cheaply, considering the loss in conductivity.

"The amount of coal burned on our locomotives for the past eight months has been 1.4 tons per 10,000 ton-miles, while for electric service nine tons per 10,000 ton-miles have been used. This is not a fair comparison, for the reason that the coal used in the locomotives was the best screened Iowa and Illinois lump, while that burned at our power house was the cheapest and dirtiest Iowa slack coal; and for the further reason that the principal part of this electric service was performed upon the city streets, where cars were stopped and started every few hundred feet, and no benefit was derived from momentum.

"The service engaged in by our switching locomotives comes somewhat nearer a comparison of the condition existing on most of the electric railroads. Our steam locomotives, when engaged in switching service, consume three-tenths of a ton of lump coal per hour, while our street cars require but 12-100 ton of slack coal per hour. The average weight of street cars is about one-third that of switching engines, so that it would be entirely fair to multiply 0.12 ton per hour by three, making 0.36 ton per hour consumed by electric cars of steam switching engine tonnage. We should divide the 0.36 ton per hour by two, as the quality of coal used by electric cars is not one-half as good and does not cost one-half as much as that used by the steam switching engine. We find, then, the result to be 0.18 ton per hour, or a saving of 0.12 ton per hour by the concentration of energy in a central station, and, in addition, the saving of one man on the locomotive."

A Criticism of the Detroit Municipal Plant.

In a discussion of the latest figures of the local electric light commission, the *Detroit Free Press* says: "In its search for a basis upon which to work, the commission has committed the error of using the contract price offered in 1895 upon which to figure the expense to the city for the intervening period had the municipal plant never become a reality. The bid by a private corporation of $102.20 a lamp per year was admittedly exorbitant, else there would have been no agitation in favor of the present system. The city had for years been in the grip of a monopoly, and to assume that the rate tendered under such conditions is a fair one upon which to base computations discloses a startling confidence on the part of the commissioners in the credulity of the public. Developments in the electrical world have come more rapidly than in almost any other line, and the cost of production has been materially lessened.

"If we mistake not, a recent offer by Mr. Dow, of the Edison Electric Company, was something less than $50 per light per year. This, presumably, included the use of the city's outside equipment, hence it could not be used in drawing a comparison. However, granting a rate of $75 as a fair basis, some startling discrepancies in the commission's findings are disclosed. Instead of having paid $2,050,668.55 for street lighting from October 1, 1895, to June 30, 1905, as the report asserts, it would have cost but $1,504,793. Passing the

cost of incandescent lights, which the commission figures on the basis of Mr. Dow's offer, it will be found that instead of a cash balance in favor of municipal lighting of $162,940.70 on the $75 per light basis there would exist June 30 next a deficit of $382,924.85. The net investment in the present plant is placd at $824,021.24, but this includes a vast amount of equipment, which, while having performed its work well, must now be practically valueless. The depreciation is heavy in a plant of this nature, and it is probable that as its actual valuation to-day, based upon the equipment which is serviceable, and not on the much lower figure it would bring in the open market, $500,000 would be, no doubt, an extravagant figure. Deducting the deficit remaining at the cost of $75 per arc light and placing the value of the plant at even $500,000, it will be found that instead of a net gain to the city in ten years of $986,962.01, there has been a saving of approximately $280,000, or more than $700,000 less than the commission's figures."

Changes in the Dates of Brooklyn Polytechnic Lectures.

Prof. Frederic A. C. Perrine, who is giving at the Brooklyn Polytechnic Institute a series of evening lectures on long-distance electric power transmission, has gone to Mexico during March on an important hydro-electric project. This has necessitated changes in the dates of the remaining lectures to be given by Dr. Perrine, as well as by Dr. Duncan. The new dates are as follows: For Dr. Perrine, April 6, 13, 19 and 27, and May 4 and 18; for Dr. Duncan, March 9, 15, 23 and 30, April 11 and May 11 and 25.

Prof. Barstow's seventh lecture, given on February 28, was devoted to metering. The lecturer gave no attention to the construction of the meters themselves, but treated broadly of the various methods which have been devised to charge for current. He emphasized the fact that electricity is not a commodity but a service, the cost of which must be based not so much on the amount of current sold as on the cost of the original equipment and the extent of the standby charges incurred in being prepared to furnish a given service at the time it is wanted.

Long Telephone Spans.

In his recent interesting lecture before the Franklin Institute, on telephone work, Mr. C. J. H. Woodbury called attention to the great length of some telephone spans.

Where lines traverse mountainous districts or water courses it is frequently necessary to build spans of great length, using either one of the special bronzes or steel wire for the purpose. The Connecticut River at Middletown is crossed by wires having a span of 1,350 ft., suspended between a steel trussed tower 185 ft. high on the east side, and a similar tower on the bluff on the west bank is 85 ft. high. From Enfield to Windsor Locks the Connecticut is spanned by a suspension bridge consisting of two steel cables 1 in. in diameter and 955 ft. long, to which are fastened 2-in. by 3-in. joists 4 ft. 4 in. long set 12 in. on centers. On this bridge are laid four cables containing 100 pairs of wires. The tower on the west bank shown in the foreground is 45 ft. high and the one on the west bank 33 ft. high.

The St. Francis River, near Madison, Ark., is crossed by a span of 1,000 ft., with the wires supported upon steel trussed towers 100 ft. in height, as it was necessary that the wires should be clear of steamers on the river, which has a varying level of 30 ft. between flood and drought.

At the Raritan Canal crossing, near New Brunswick, N. J., a 60-ft. span is raised 112 ft. above the canal to avoid the shipping.

Long spans are frequently strung in cases of emergency, as when the flood of June 2, 1903, carried away the bridge crossing the Kaw River at Kansas City, Mo., and also the wires attached to it, a span of wires 900 ft. in length was immediately suspended between high spars erected on either bank. The Missouri River at this city is crossed by a span of 1,500 ft., consisting of fifty No. 8 bronze wires suspended between steel trussed windmill towers 80 ft. in height.

The Delaware River at Yardley, Pa., is crossed by an aerial span of 1,300 ft. in length with a dip of 10 ft. In all instances it is necessary to use great care in the anchorage of these long spans, for a rigid attachment would cause the wires to become broken when swayed by the wind.

The Mosquito Pass, near Leadville, Colo., is crossed at an elevation of 13,130 ft. by a line of poles which were set only 15 ft. apart at the more exposed places, but even this construction did not resist the storms of winter. Telephone lines were afterward maintained through this Alpine exposure by an expedient as far out of the ordinary as the celebrated venture of Lord Timothy Dexter in sending warming pans to the West Indies, and that was by replacing the line of poles by submarine cable carried to this elevated site in continuous coils, as in the case of wire transportation over the mountain trails upon a train of mules, and laid in trenches among the rocks to avoid any disturbances from avalanches. There have been instances when it was necessary to make expeditions to these altitudes in severe weather to make repairs. The rough valleys through which the routes pass are picturesque in summer, but in winter the snow accumulates to such depths that linemen attend to their duties on snow shoes, reaching the lines on 25-ft. poles as if they were wire fences. Among these mountains are ravines which can be crossed only by long spans, where the difficulties are increased by the inclination between the opposite ends of the span, which produces severe end thrusts at the points of support, which are built of three poles capped by cross beams which must be held by the most secure guying. A few of these spans will illustrate the conditions necessary to be overcome in order to extend the telephone to these isolated mountain towns, at all times difficult of access, and during the long winter a hermitage were it not for this telephone service. Imogene Basin, Colo., at an elevation of 13,700 ft., is crossed by a span of 950 ft., which inclines at an angle of 27°. Near Telluride and the Tomboy mines, ravines are crossed by similar long spans. A surveying party, arranging for the extension of some of these lines, found the snow to be 20 ft. deep in these basins in the middle of July, while avalanches had rolled down opposite sides of a valley, leaving a narrow pass bordered by snow and ice 100 ft. in height. These lines running from the valleys up to great elevations on the mountains are charged with atmospheric electricity, particularly in winter, which is discharged to earth by bridging retardation coils across the lines and grounding the central part of the coils.

The surveying party noted that these disruptive discharges of static electricity occurred about 16 times a second, producing a continuous sound which could be heard by one near to the wires. The mountain appeared to be enveloped by static electricity, the poles and the engineers' transit glowed with St. Elmo's fire, an irritation was felt at the head, and the hair would fly up if the hat was removed. This electric envelope did not appear to extend to the ground, as one was entirely free from any sensations when lying down, but if, while in such a position, a hand was raised to about 3 ft. above the ground, a sharp sputtering sound of static electrical discharges would occur.

The Farmer and the Telephone.

An interesting pamphlet on the use of the rural telephone has just been issued by the North Electric Company, of Cleveland, which has done much to introduce the telephone among the farmers of America. One passage says:

"Telephone tea parties are now in vogue on farm lines. There are telephone evening musicales. The accomplished contribute the programme, while others, scattered over an area of many miles, form the audience. The resullt is more satisfactory than the phonograph. By the way, the telephone is a "circulating library" or medium of exchange for phonograph records.

A news service is one of the innovations of rural telephones. At seven o'clock in the evening a general call is rung. When each subscriber is at his instrument, the exact time is given—for instance: "It is now one minute and a half past seven." Then are the weather indications; then the late afternoon national and international news, the extent of which is about that contained in the head lines of the average city newspaper. Following this are the markets—oats, wheat, corn, hay, live stock, butter and eggs. Then the local news, and a portion of the time reserved for questions of detailed news and special market quotations. McKinley's death was known to farmers ten miles from market towns as soon as in the cities." It is not too much to say that the telephone is working a revolution in rural life which in time will form an important chapter in sociology, and the market information thus disseminated has already brought about sharp readjustment with middlemen.

Ontario Power Plant at Niagara.

The Ontario Power Company, of Niagara Falls, has received the second 10,000-hp generator manufactured by the Westinghouse Electric & Manufacturing Company. These generators are 7,500-kw, 12,000-volt, 25-cycle machines, running at 187½ r.p.m., and will be direct-connected to double-spiral inward flow Francis type turbines of 11,390 hp, designed and manufactured by J. M. Voith, Heidenheim a.d. Brenz, Würtemburg, Germany. The bedplates of the first unit have been grouted in place, and the work of assembling is nearing completion. The 9-ft. penstocks for units Nos. 1 and 2 have been completed and the ends closed preparatory to hydraulic testing.

The concreting of the 18-ft. conduit is practically completed, and the backfilling with earth has begun. The conduit is laid in a trench, and when completed will be covered from four to twelve feet, the earth sodded and the scenic beauty of Victoria Park, through which it is laid will be restor,ed. To carry the earth load, besides having seven-inch bulb tee stiffeners spaced four feet apart, the whole conduit is encased in concrete from one to three feet in thickness. The conduit was built in place, and is made of one-half inch steel plates, sheared, punched and rolled on the ground. After sand-blasting, three coats of paint were applied to the outside, and two to the inside. To prevent electrolysis copper conductors have been soldered to each ring, and to a heavy common conductor which is connected to the grounded terminal of the street railway plant, whose line parallels the conduit.

This conduit will carry 3,800 second-feet of water at a velocity of 15 ft. per second, or enough to develop 60,000 hp. under a head of 175 ft. Six vertical penstocks 9 ft. in diameter, taken off at the under side of the conduit, will conduct the water to the turbines.

After passing the penstocks, the conduit turns up and ends in an open spillway, thus preventing water hammer by providing a spill for excess water. The excess water flows smoothly over the well-rounded crest of the spill into a channel, the excavation for which has been completed ready to receive the lining of steel and concrete. The shape of this channel or tunnel is of particular interest. To obtain the desired point for discharge at the river level, and have a continued smooth flow, the channel is of uniform grade constructed on the line of a helix, and advantage is taken of the increasing velocity of the water due to gravity, by beginning it with a taper section, and gradually narrowing to a uniform circular section.

The work on the valve chambers directly under the 18-ft. conduit, where the 9-ft. turbine supply pipes take off, is progressing rapidly. The concrete arches over the housings and operating mechanism of three valves have been completed, so that the 18-ft. conduit may be extended over the penstocks. Each conduit will regularly supply six penstocks, and the seventh may be supplied either from conduit No. 1 through a cross connection, or directly from conduit No. 2. The 9-ft. valves are operated by 30-hp. electric motors ,and were made by Ransomes & Rapier, London, England, and Pratt & Cady, Hartford, Conn.

CURRENT NEWS AND NOTES.

THE MERCURY ARC RECTIFIER.—On Tuesday evening March 21, Mr. Alexander Churchward will lecture before the Automobile Club of America, New York City, on "The Mercury Arc Rectifier—The Latest System for Transforming Alternating Current into Direct Current for Charging Storage Batteries" with a demonstration of the apparatus.

BARRING DIRTY STREET CARS.—The Scranton Avenue line of the Cleveland Electric Railway Company was tied up for two hours last week because a motorman and conductor attempted to take out a street car that did not meet the standard of cleanliness which the city health officer is putting in force. It was stopped by agents of the board. Recently Health Officer Friedrich started a crusade against dirty street cars, and has since had his deputies inspecting the sanitary condition of the cars on the several lines. The health officer ordered that the cars be scrubbed at certain times and a standard of cleanliness necessary to health maintained. The health board is considering an ordinance to limit the number of passengers that each car shall permit to board. It will be interesting to see how the Cleveland public will submit to this latter requirement, limiting the privilege to take the first car that comes along.

A CURIOUS ACCIDENT.—A peculiar fatality occurred in Boston on March 14, when a workman named Bohm, employed on the Edison Electric Illuminating Company's building at 29 Hawkins Street by the Albert & J. M. Anderson Company, was boring a hole in a brick wall from the inside of the building. When the drill reached the outer wall it struck a live wire on the outside and death was instantaneous.

HEAVY STREET CAR TRAVEL.—On Tuesday, the first day of the Interborough strike, the New York City Railway carried 2,300,000 persons, which is a record for surface travel in New York. The normal business is about 1,000,000 cash passengers and 600,000 transfers. Other days last week were in proportion to Tuesday, but the street car travel declined somewhat as the underground and elevated facilities returned to the normal.

NEW YORK LIGHTING.—The New York Aldermen have approved the appropriation of $600,000 made by the Board of Estimate for the purchase of a site for a municipal electric lighting plant. Some of the Republican members of the board opposed the resolution. Alderman Meyers insisted that the administration was not sincere and spoke of the project as "a cheap bluff." The appropriation was carried without a dissenting vote. This land was to "cost the city nothing," according to the municipal plant advocates, but later $400,000 was appropriated for sites.

THE TELEPHONE IN AMERICA.—The *Electrical Times,* of London, in commenting on the United States Census Bulletin regarding telephones, speaks of the extensive spread of the telephone habit in this country as bearing evidence to the keen business insight of Americans. The *Times* says: "In fact, in America the telephone is becoming a familiar instrument in the hands of classes that in this country would never look at such a thing otherwise than as a curiosity." Referring to the data furnished, the *Times* intimates that such work makes a British statistician turn green with envy.

RAILWAY ELECTROLYSIS.—The annual report of the Metropolitan Water and Sewerage Board of Massachusetts, submitted to the Legislature on March 14, states that in reference to electrolysis the most serious effects upon the pipes have been found in the vicinity of the power stations of the various electric railway companies; that experiments have been made without much success in applying to the pipes an insulating covering of asphalt and burlap, but that some success has attended the use of insulated joints in the pipes. Legal proceedings for reimbursement have been delayed to await further developments of these experiments.

INDEPENDENT ELECTRICAL CONTRACTORS' ASSOCIATION OF GREATER NEW YORK.—The Independent Electrical Contractors' Association of Greater New York has been organized with the following officers: President, Mr. John T. Whitehead; vice-president, Mr. A. Newburger; treasurer, Mr. C. Schafer; recording secretary, Mr. M. F. Fleck; financial secretary, Mr. C. A. Christesen. The board of directors consists of the officers and Messrs. C. D. Beinert, E. Christensen, F. Benn and I. J. Fajans. The offices of the association are at Columbian Hall, 52 Lexington Avenue, where meetings are regularly held on Wednesdays at 4 p.m.

SMELTER CHIMNEY FOR WIRELESS.—The Denver *Times* of March 6 says: "Every city within a radius of 200 miles will be able to communicate with Denver by means of the wireless telegraph within two weeks. Installation of a wireless telegraph office was begun yesterday at the Grant smelter. The immense chimney, 353 ft. in height and the third highest in the world, has been fitted up and wired. A 20-hp plant is being put into operation and C. B. Cooper, the supervising engineer for the American De Forest Wireless Telegraph Company, states that the Denver station will be made one of the largest of its kind. The smokestack of the Grant smelter is more than 100 ft. higher than any other tower now being used. A mast 212 ft. in height, which was recently shipped to Denver, will be sent to Pueblo and a branch office opened there."

UNIVERSITY OF SOUTH DAKOTA.—The University of South Dakota needs an assistant professor in the department of engineering, at a salary of $1,200 for the first year. The University is at Vermillion, S. D. Prof. A. Pell is the director of the department.

FREE WIRELESS TELEGRAPHY.—In the latter part of February wireless telegraph messages were clearly received at Fort Mason by a receiver attachd to an eucalyptus tree, in one case from the Mare Island Navy Yard, and in another case from the naval hospital ship *Solace,* as she was approaching San Francisco harbor. The receiver connected with the tree was a De Forest responder.

PHILADELPHIA SUBWAYS.—The plans of the Philadelphia Rapid Transit Company contemplate the commencement of work on the ten-mile underground railway in Broad Street about the time the Market Street subway and elevated line is completed from the Delaware River westward. In a general way, plans for an underground railway in Broad Street have been passed upon in an unofficial manner by the Rapid Transit Board of Directors. The engineers figure that the cost of this undertaking will be approximately $1,000,000 a mile.

PROTECTING CABLES AGAINST EXCESS PRESSURE.—A patent, issued March 7, to Georg Zapf, of Berlin, Germany, relates to the protection of electric cables from excess pressure produced by internal electric action or by lightning. A section of the cable is selected where the insulation is purposely made weaker than elsewhere, though being of sufficient strength to withstand normal voltage. Around the insulation of this section is wrapped a copper wire leading to the earth. The intention of this arrangement is to insure that the insulation will be penetrated at the chosen point and not at some other.

SEARCHLIGHT FOR REVOLVERS.—Mr.. B. C. Riblets, of Spokane, Wash., on March 7, obtained a patent for a curious means of applying an electric light and battery to revolvers in such a manner that the light therefrom can be utilized to search and illuminate the object at which the user wishes to point the revolver and at the same time to screen the user. He would place a miniature dry cell in the handle of the revolver, with a hood provided with a reflecting surface and containing an incandescent bulb electrically connected to the cell, located at the underside of the barrel of the revolver.

A FREIGHT SUBWAY.—Following the example of Chicago, a plan is being considered by the Merchants' Association for the construction by the city of a subway for handling freight. Charles R. Lamb, the architect, suggested the plan. He maintains that by means of a subway encircling the lower section of the city and connecting with the railroads the heavy trucking can be eliminated from the streets, and in a great measure also the obstruction of great fleets of tugs and lighters from the bay and rivers. The tunnel, if built according to the plans which have been prepared, will start at Cortlandt Street and the North River, where connections will be made with a tunnel from New Jersey, to be used by the Central Railroad of New Jersey and the Philadelphia & Reading. At Christopher Street it is planned to meet the tunnel of the New York & Jersey Company, giving connections with the Erie and the Lackawanna. Connections are also planned uptown for the Pennsylvania, the West Shore, the New York Central and the Long Island.

SELF-STARTING SINGLE-PHASE MOTOR.—In order to combine in an alternating-current motor the ability to operate at speeds below the normal running speed and at the same time to secure at normal speed the maximum output of which the windings are capable, Mr. W. A. Layman, according to a patent issued March 7, would provide the armature of a single-phase induction motor, started as a repulsion motor, with a large number of circuits capable of being short-circuited at normal running speed, thus decreasing the resistance of the armature windings and securing a motor of a greater capacity than has heretofore been obtained in this type. For this purpose there is used a second winding in addition to the usual one, which is connected in the well-known way to the commutator. This separate winding is connected at three symmetrically placed points to slip rings, the brushes on which connect to a three-phase resistance which may be adjusted in value at will by means of a three-arm switch. It is possible to cause one winding to perform the function of both, thereby simplifying the construction.

CURIOUS TELEPHONE DATA.—President F. P. Fish, of the American Telephone Company, in an address before the Beacon Society, stated that the energy required for a single incandescent burner is 5,000,000 times as great as that required to send a message to Chicago, and that the energy required to lift a weight of 13 ounces is sufficient to operate a telephone for 240,000 years. Mr. Fish stated that the number of telephone subscribers has more than doubled in the last three years over the total of the previous twenty-four years. He was confident that the next three years will see the present number more than doubled. He predicted that the telephone in the not distant future will exceed the mail in the number of messages per day. He said that to meet all the requirements of the service 1,000,000 trees a year are required for poles, and the average cost of every class of messages is 2.2 cents, which is not much more than that required on the average for messages by mail. Three years ago twelve telephones for every 100 of population were considered the maximum that it was possible to supply. Now the telephone people are looking ahead to a maximum of twenty for every 100 of population.

ELECTRICITY IN SHEFFIELD.—Mr. C. N. Daniels, United States Consul at Sheffield, England, notes that the year 1904 was notable for the opening of the power station at Neepsend. There has been a notable increase in the demand for electricity. A few years ago only a very small number of motors were in use; now they may be found driving all kinds of machinery. Electric motors to the extent of 115 hp were applied for in the year. Customers have increased in number from 2,549 to 3,000. The lamp connections have reached a total of 275,363. The units sold up to last March were 3,980,049, and it is estimated that 5,000,000 will be reached by the end of the current year. After paying all charges the department had a surplus at the end of the financial year of £5,431 ($26,429) against £6,534 ($31,797) at the end of the previous year. The receipts of the Sheffield tramways in 1904 amounted to £235,939 ($1,148,197), an increase of over £7,000 ($34,065) over 1903; 62,579,866 passengers were carried and 5,658,926 car miles were run during the year. The total number of cars is 247, an increase of 29 in the year. The average number of ordinary cars running daily is 139 and 58 special cars. There are over 64 miles of single track (excluding depots), and the total number of employees is 1,386.

SO SAY WE ALL.—The New York *Times,* discussing another of Comptroller Grout's crazy performances, says: "No palliations can be urged in behalf of Comptroller Grout. His letter to the Interborough Company is the fine flower of a calculated and imbecile demagogy. How on earth any man in office or in politics, or out of both, could expect to achieve popularity by taking a position so deserving of universal public condemnation and so sure to receive it is quite beyond conjecture. Mr. Grout told the Interborough Company that it would be his duty to insist that the cost to it of the strike should not be included in the operating expenses of the Subway when making up the report upon which would be based the calculation of the payment to the city of 1 per cent. of its profits in excess of 5 per cent. The Comptroller's position is that during the continuance of the strike receipts would be very much diminished, the expenses enormously increased. 'It is impossible,' he writes, 'for the city to permit such a contest to proceed at the expense of the city.' Mr. Grout here formulates a new principle in corporation bookkeeping, but that is a very trivial matter compared with some of the other aspects of his attempt to make personal capital out of the strike. The Interborough Company may have been put to some extra expense on account of the strike. If so the expenditure could hardly be charged to the account of whim or of luxury, of pride or of pleasure. The money was spent in attempting to keep the Subway trains running, in the attempt to provide an adequate passenger service, in the effort to carry hundreds of thousands of passengers from their homes to their business with as little delay and inconvenience as possible. If the company had not spent this money it could have run no trains at all; it would have been obliged to abandon its service. In that case Comptroller Grout would have been the very first to insist on the forfeiture of the Subway contract for non-user. Practiced demagogues always try to catch occasion going or coming."

A CABLE TIME CHART.—The Commercial Cable Company has just issued a very interesting and useful time chart, broadsheet form, giving the time difference between New York and about 220 leading commercial and political cities all over the world. The names are printed in blue and red. The times given in blue have to be added to any given time in New York. The times in red have to be deducted.

RADIUM AND RATTLESNAKES.—A new use for radium was announced at a meeting of the Académie des Sciences, Paris, last week by Professor Chaveau. It is found that radium destroys the toxicity of the venom of serpents. The venom of the viper and the cobra if submitted to the action of radium for 50 or 60 hours entirely loses its virulent properties. In cases of poison of the toad and the land salamander, the emanations only have effect after about seven days.

A. I. E. E. MEETING.—The 195th meeting of the American Institute of Electrical Engineers will be held at the Chapter Room, Carnegie Hall, West Fifty-seventh Street, Friday, March 24, at 8.15 p.m. The following papers will be presented and discussed: 1. "Line Construction for High-Pressure Electric Railroads," by George A. Damon. 2. "High-Pressure Line Construction for Alternating-Current Railways," by Theodore Varney. 3. "Application of High Pressure to Electric Railroads," by Ernest Gonzenbach.

CABLE RATES IN CANADA.—The Dominion minister of railways has announced that the government has given the Anglo-American Cable Company $5,000 increase in subsidy for an improved cable service between Prince Edward Island and the mainland. By the agreement the company has reduced its rates on messages from points in Prince Edward Island to Nova Scotia, New Brunswick, Quebec and Ontario from 50 cents to 30 cents for 10 words, and from 3 cents to 2 cents for each additional word. A proportionate reduction is made for press messages. Rates to Manitoba, British Columbia, the territories and the United States are reduced from 50 cents to 25 cents for 10 words, and from 3 cents to 2 cents for each additional word. To this the rates of connecting lines must be added under the new agreement.

TROLLEY CARS FOR DAMASCUS.—A special dispatch from Cairo, Egypt, of March 4, says: "Trolley cars will soon run through the picturesque streets of Damascus and the region thereabouts. A syndicate headed by M. Empain, the Belgian financier, who is connected with the Paris Metropolitan Railway, has acquired from Izzet Pasha the concession granted to the latter by the Sultan for the construction of electric light and power works and tramways at Damascus. The syndicate has paid for the transfer of the concession $130,000 in cash and $20,000 in shares of the company to be formed to carry out the scheme, with a capital of $1,250,000. The concession carries with it the right to utilize for the production of electrical power all the available water power within a distance of eighteen miles of Damascus, which includes streams that ran red with blood shed by the Crusaders."

OVERHEAD WIRES IN LONDON.—A cable dispatch from London of March 4 says: "People grumble a great deal about the telephone service in London, but they are now finding out what a terrible thing it is to be without it altogether. At any rate, there are now six thousand subscribers in the city who this week were forced to do without a telephone, and many of these may be in the same unfortunate position for some time to come, owing to the most disastrous fire which the telephone company has ever experienced. The fire, which occurred at the Bank Exchange, was strangely caused. The origin of it was two miles away near Westminster Bridge. A little fire in the cable subway there caused a short circuiting at the Bank Exchange testing room on the roof. High voltage resulted in a spark, which set the testing house on fire. The flames ran up an immense iron derrick, or four-sided tower carrying scores of thick cables. As wax enters largely into the insulating material of these cables they burned furiously. The flames sped along the wax cables over the house tops with extraordinary speed, until the sky around the Mansion House seemed to be full of fiery serpents. The fire brought home to Londoners for the first time the possibilities of overhead telephone cables as agents in spreading conflagrations. In the present instance, however, the damage was confined to the wires and derricks and to the test house, which was completely destroyed." This is a graphic if not accurate description.

PRINTING TELEGRAPHY.—For the purpose of maintaining synchronous operation of motors used in printing telegraphy and multiplex telegraphy, Mr. Paul Thomas, according to an invention patented March 7, proposes to regulate the speed of the motor by applying two forces, one adapted to act upon very small and short deviations of speed, and the other being called into play when deviations of longer duration take place. From the motor, which serves to set the speed of the system, contact in a circuit from a source of power is made once for each revolution of a disc driven by the motor. On each motor, whose speed is to be kept synchronous with the above machine, is mounted a similar disc having three contact studs, the center one of which would come into direct contact in the supply circuit simultaneously with the one on the speed-setting motor for synchronous operation; and one or the other of the remaining two studs would complete the circuit to accelerating or retarding devices, according as the speed is too low or too high. The device insures not only that the speeds of the various motors are synchronous, but that the several machines remain accurately in step.

COWBOY AND BRONCHO.—The battle of the cowboy and the broncho will be one of the interesting features of the entertainment which will be furnished the delegates to the convention of the National Electric Light Association, which begins in Denver, June 6. The committee has arranged to hold a broncho-busting contest for the amusement of those who attend the convention, and the most expert riders among the cowboys of the West will contest for the prize to be offered. The event will be of intense interest to those who have never seen anything of the picturesque life of the American cowboy. The plans of the different committees are proceeding smoothly, and the outlook for a successful convention is most promising. The convention will be given satisfactory financial support. The finance committee is in receipt of liberal contributions from Denver and Colorado Springs. The people of Colorado are always hospitable to their guests, and those who attend the convention will be given a rousing reception. In a few weeks the programme committee will be able to furnish an outline of the work and features of the convention week.

SUBWAY BACTERIA.—Dr. W. H. Park, director of the research laboratory of the New York Board of Health, has made a report as to the allegation that bacteria in the New York Subway are unusually numerous and pernicious. "With respect to the bacteria which are carried into the Subway in various ways," Dr. Park says, "It may be said, first, that generally there are fewer of them to be found in the dust and soil of the Subway than outside. The air in winter is drier, and the absence of moisture is always a powerful germicide. The very drying up of the material in which bacteria are found is sufficient in itself to kill from 80 to 99 9-10 per cent., according to the variety and the conditions apart from the drying of all the bacteria to be found therein. At Seventy-second Street I gathered about one-fiftieth of a gram of dust from the top of a girder reaching across the top, and about one-fiftieth of a gram of dust from the sidewalk on the outside. After forty-eight hours I found that in the dust gathered from the Subway girder there developed in nutrient agar 240 colonies of bacteria, while from that gathered from the outside there developed 820. At Eighteenth Street a similar experiment with a similar quantity of material showed after forty-eight hours, 650 colonies from the dust gathered from the floor of the station as against 2,000 from that gathered from the sidewalk. Material gathered from the entire lower edge of the frame of an advertising sign standing on the floor of the Times Square Station showed eighty colonies. A similar quantity taken from the top of a frame resting near the floor in the Times Square gathered from the entire lower edge of the frame of an advertising sign standing on the floor of the Times Square station showed eighty colonies. A similar quantity taken from the top of a frame resting near the floor in the Times Square station showed seventy colonies. At Eighteenth Street I rubbed a swab over the whole of the lower end of a frame of an advertising sign which was fixed in the wall, and at some distance above the floor, and from the material thus gathered only eight colonies developed. These experiments show conclusively that at the present time the dust in the Subway as a general proposition is freer from bacteria than that to be found outside in the streets."

Single-Phase Railway of Indianapolis & Cincinnati Traction Company.

A DESCRIPTION was given in the issue of February 18 of some of the features of the single-phase traction system of the Indianapolis & Cincinnati Traction Company, which we are now enabled to supplement with some further information.

The power station for the entire system of 120 miles of road is located at Rushville. At present gas fuel is being used, but there are railroad track connections which will enable coal to be delivered at the bunkers should the gas supply fail. The side track along the power station is built at a proper level for the dumping and crushing of coal, so that it can be handled by carrier and elevator and fed under the boilers on chain grates without manual handling of any kind.

The station building is 113 ft. by 128 ft. 10 in., and is of very heavy and substantial construction. The foundations are of concrete and the upper walls are of brick laid with cement mortar. The floors and other framework and roof structure are of steel. Floors are of concrete and a gravel asphalt roof is laid upon a concrete base with expanded metal, leaving nothing about the building that can burn except the doors and windows. The building is designed and constructed with a view to the installation of coal-crushing and automatic coal-handling machinery, with overhead bunkers feeding direct to the boiler grates. As natural gas is being used as fuel at the present time, the coal bunkers and carriers have not yet been put in, but everything is prepared for their installation, even to the punching of holes in the steel structure from which the coal bunkers will be suspended.

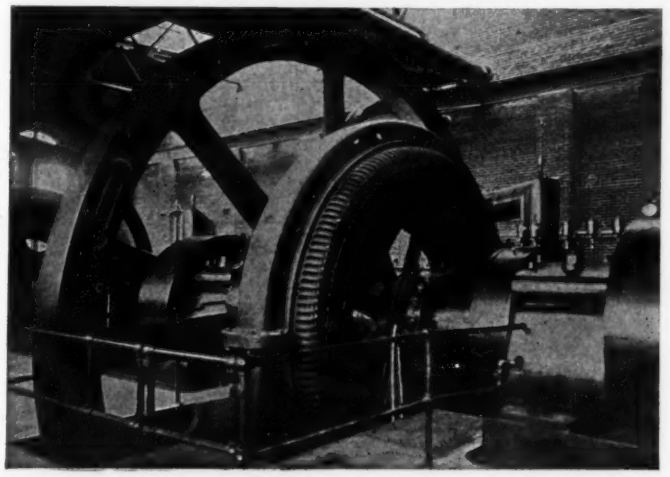


FIG. I.—A GENERATING UNIT.

Foundations for the engines, boilers, pumps and other machinery are all of solid concrete. Stairways are made of either steel or concrete. The cellars and chambers for electric wires, cables, switches, transformers, protective apparatus, etc., are built according to the most modern practice and in the most substantial manner. The structural and architectural features of the building were designed by Sargent & Lundy, the consulting engineers, and constructed under their supervision.

A concrete tunnel or pipe 3 ft. 6 in. in diameter, running under the basement floor, conveys the water from the mill race to the condensers, and a similarly constructed tunnel is provided to carry the water back again to a mill race running by the power house, connecting at a point some 300 ft. below the intake. The supply tunnel is provided with an intake crib which is equipped with an iron grill and removable screens.

At the east end of the power station erected upon a heavy concrete base is a well-proportioned, self-supporting steel stack 180 ft. high, lined its entire length with fire brick. The inside measurement of the stack is 11 ft. It is of sufficient size to take care of eight 350-hp boilers, space for which is provided in the present building.

The power house is so framed and constructed that the west wall can be taken out without disturbing the other walls or the present steel framework, and the building extended to the west. For this purpose a space of over 200 ft. has been reserved for extensions to accommodate the future needs of the company.

The present equipment includes three Babcock & Wilcox water-tube boilers of 350 hp nominal capacity each. Each boiler contains in the setting a Babcock & Wilcox superheater proportioned for about 100° of superheat. Space is provided in the building for five additional boilers of the same capacity, which will be installed as rapidly as additional power is required. Natural gas is now being burned, but the boilers are equipped with flat grates set in an extension furnace, the setting being arranged so that chain grate stokers can be easily installed when the coal-handling apparatus is put in.

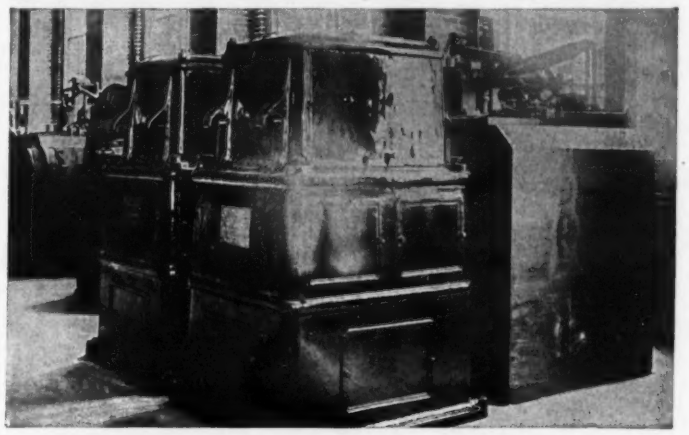


FIG. 2.—AIR-BLAST TRANSFORMERS AND OIL SWITCHES.

The boiler room is equipped with a large open exhaust feed-water heater of the Stilwell-Bierce make, and with two vertical "Atlantic type" Dean feed pumps.

The engine room is provided with a traveling crane, built by the Northern Engineering Works, of Milwaukee, of sufficient capacity to handle all their machinery, and which greatly simplifies the work of installation. The present generating equipment, as stated in the previous issue, includes two 700-hp Corliss type, cross-compound, condensing engines, built by the Fulton Iron Works, of St. Louis, Mo., operated at a steam pressure of 140 pounds. Each engine is equipped with a Dean independent steam drive jet condenser. The condensers are set in the basement, but are arranged for operation from the main floor level.

Each engine is direct-connected to a 500-kw, 2,300-volt, three-phase, 25-cycle, Westinghouse revolving-field alternator, running at a speed of 94 r.p.m. The frames of the stationary armatures are of cast iron and surround inner cores of laminated steel, which are built up with overlapping joints so as to form a circular ring, slotted to receive the coils. The slots are of the partially closed type. The field core is formed of laminated punchings, dove-tailed to a cast-iron spider. It has 32 poles on each of which is wound a machine-formed coil. The generators will develop full load continuously

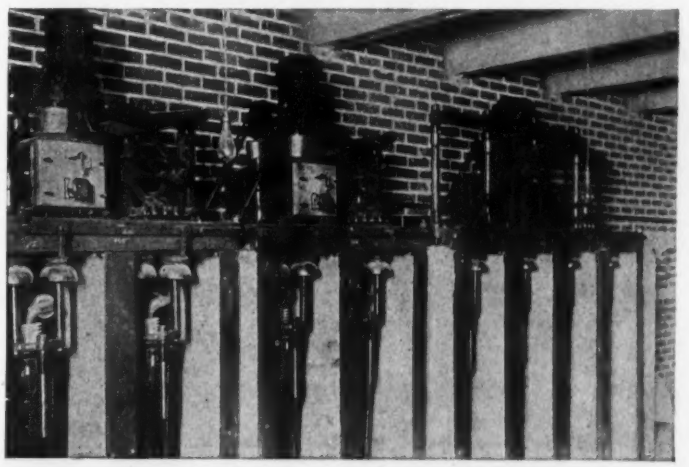


FIG. 3.—ELECTRICALLY-OPERATED CIRCUIT-BREAKERS.

under normal conditions with a temperature rise not exceeding 35° C. above the surrounding air, and immediately following such a full load will carry 50 per cent. overload for a limited period with a temperature rise not exceeding 55° C. The generators have a close inherent regulation, but arrangement has been made to further control the voltage by means of Tirrill regulators mounted on the switchboard. The present engine room provides sufficient space for the installation of two additional generating units.

Two exciter sets have been installed, one of which is driven by a Westinghouse compound steam engine, the other by an induction motor, which in turn is driven from the main circuit through transformers.

The generators are connected directly to two pairs of 250-kw air-blast transformers, which are connected according to the Scott three-phase, two-phase system, to transform the current from 2,300 volts, three-phase, to 33,000 volts, two-phase, at which higher potential it is delivered to the transformer stations along the line of the railway, and to the lowering transformers in the power house which supply the

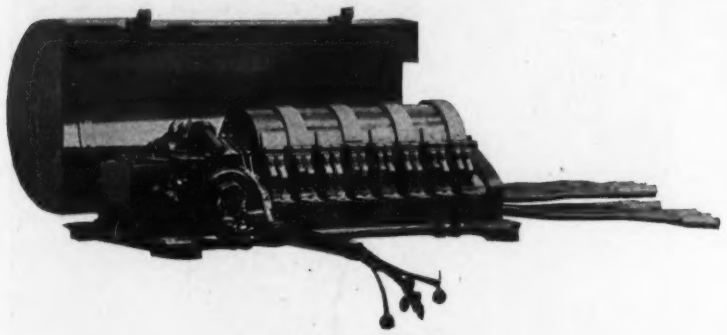


FIG. 4.—REVERSER.

portions of the trolley located in and near the city of Rushville. Air to cool these step-up transformers is furnished by a pair of 90-in. Sturtevant fans driven by Westinghouse induction motors.

The air-blast transformers are connected in pairs, and each pair is connected in turn with its own generating unit. The high-tension coils of the transformers are divided so that they may be connected for 16,500 or 33,000 volts, while the low-tension winding is designed for 2,300 volts, the potential of the generators. The insulation between the high-tension coils and core was submitted to a test of 66,000 volts alternating current for one minute, and for the same length of time a potential of 4,600 volts was applied between the low-tension coils and core. These transformers are designed to carry full load for twenty-four hours with a temperature rise of

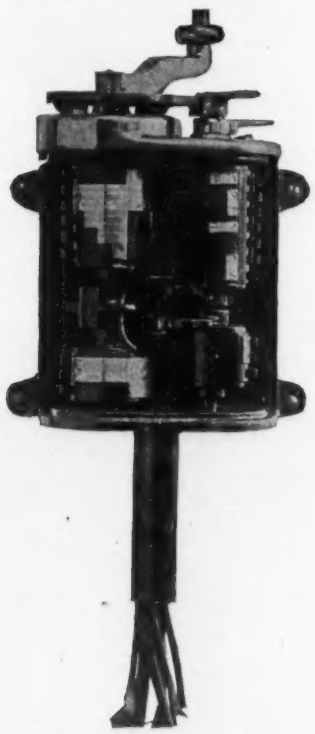


FIG. 5.—MASTER CONTROLLER.

25° C. above the temperature of the surrounding air, and after a full load run under these conditions each will carry an overload of 40 per cent. for two hours with a final temperature rise not exceeding 55° C. Their efficiencies are approximately as follows: Full load, 97.4 per cent.; three-quarter load, 97 per cent.; half load, 96.1 per cent.; one-quarter load, 92.8 per cent.

Between the high-tension coils of the step-up transformers and the main bus-bars, 33,000-volt, oil-insulated, electrically-operated, two-phase, non-automatic switches have been installed. On each outgoing feeder leading to the transformer stations a double-pole automatic switch of similar type has been inserted, and each outgoing feeder is also protected by disconnecting switches, which were made by the Westinghouse Company in accordance with de-

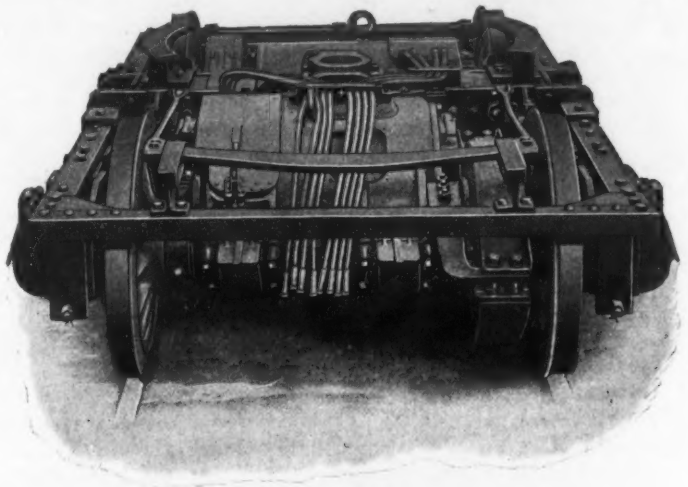


FIG. 6.—MOTORS AND TRUCK.

signs specially prepared by Sargent & Lundy, the consulting engineers.

The generators are connected in parallel. The operating panels are located in the main engine room, forming two switchboards of blue Vermont marble. The first board is composed of five panels and provided with apparatus for the control of the two exciter sets,

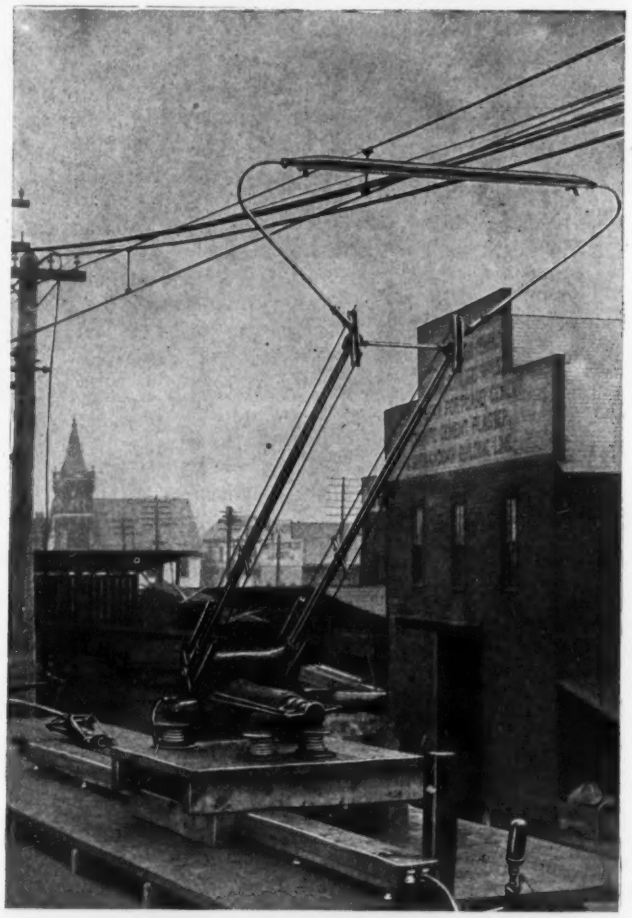


FIG. 7.—BOW TROLLEY.

the motors which drive the ventilating fans for the step-up transformers, and the ammeters, voltmeters, wattmeters, Tirrill regulators, synchroscopes and switch control mechanism for the two 500-kw main generators. As has been stated, all the switches are electrically-operated, current for this purpose being supplied by the exciter set. As, however, the generators are governed by Tirrill regulators, it has been thought wise to install a specially designed booster set in the switch-operating circuit, in order that the e.m.f. of the exciters may not be so reduced by the action of the Tirrill

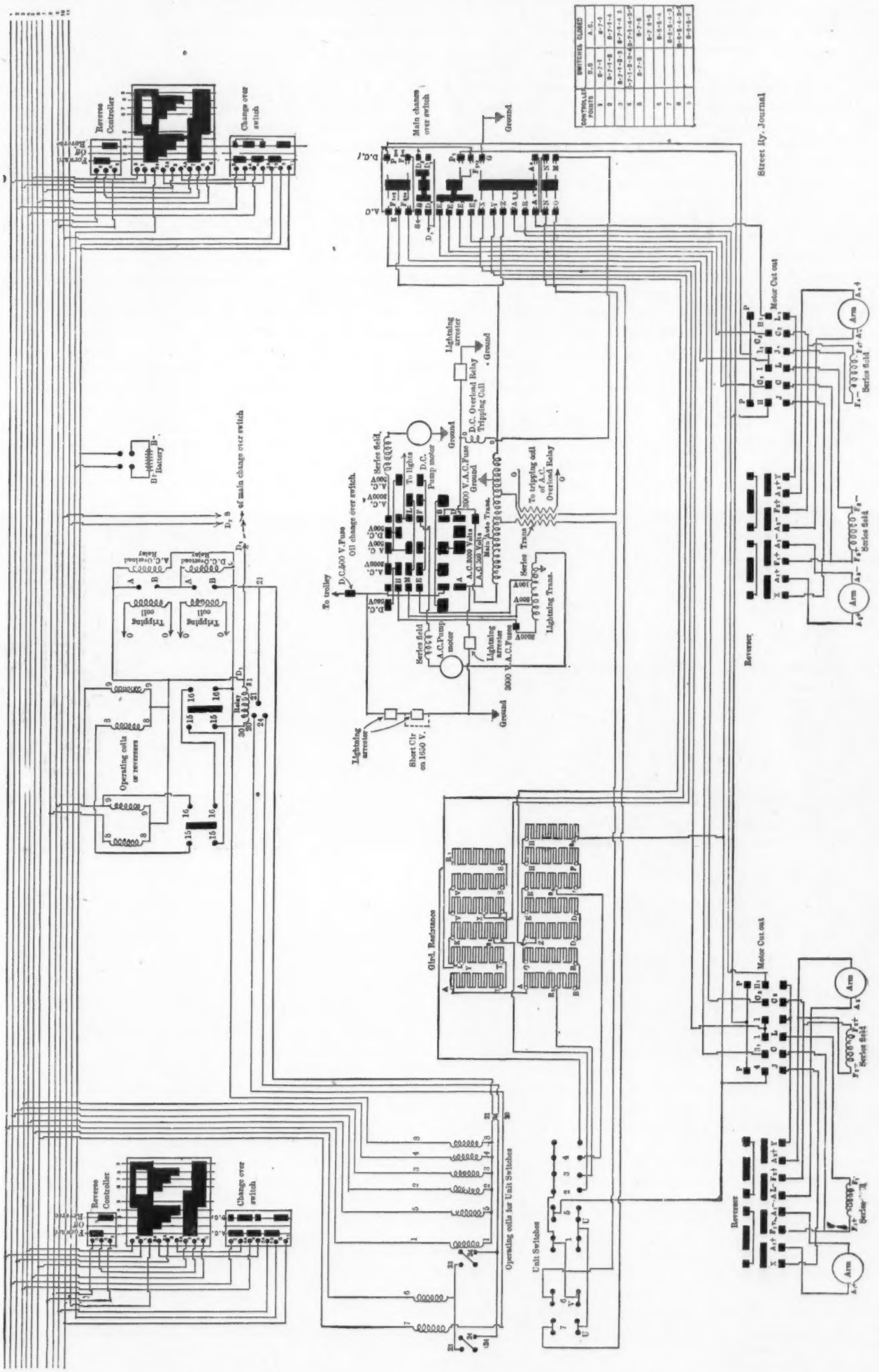


FIG. 8.—DIAGRAM OF CAR WIRING.

regulators that the switch mechanism may fail to act, and in this way all possibility of failure has been overcome. The second switchboard is composed of twelve blue Vermont marble panels, designed to control the outgoing feeder circuits. Five of these panels are now blank, but will be equipped with the necessary apparatus when the operations of the road are more extended. The main bus-bars occupy a portion of the basement. They are mounted upon heavy insulators, which are supported upon a masonry structure which is very heavy and substantial. Provision has been made so that the air from the transformer fans is carried through the bus-bar chamber. The bus-bars are arranged in a double set, each of which is protected by a disconnecting switch.

The east end of the building constitutes what is called the high-tension chamber, and is divided into four floors. The basement contains the bus-bars, which are mounted similarly to those leading from the generators, together with the instrument transformers. On the main floor are installed the oil-insulated, electrically-operated, high-potential switches which are controlled from the panels in the engine room, the lowering transformers from which the 550-volt, alternating-current trolley line in the city of Rushville is operated, the lowering transformers—33,000 volts to 3,300 volts—which feed the sections of the trolley immediately next to Rushville on either side, the lowering transformers for the operation of the motors which drive one exciter and the ventilating fans in the engine room, and the static interrupters for the protection of the lowering transformers.

On the third floor have been installed the static interrupters, which are connected to the main outgoing feeder lines, while the low-equivalent lightning arresters are mounted upon the fourth floor of the high-tension chamber. It will be noted that all switching is done on the high-tension side.

The general plan of operation is the transmission of alternating current over single-phase circuits at 33,000 volts to transformer stations, which are located every 10 miles or 12 miles along the road, where the potential is reduced to 3,300 volts and connected direct to the trolley. The transformer stations require no attention, as the feeder lines are all controlled from the main power house and no moving apparatus is installed in the transformer houses. Because of the high potential at which the current is transmitted and fed to the trolley, no auxiliary feeders are necessary, and the total expenditure in copper is exceedingly low. The possibility of this saving constitutes one of the most important advantages of the alternating-current, single-phase railway system.

As the cars must be operated over the tracks of the local railway companies in the city of Indianapolis, which are all supplied with direct current, it was necessary in their equipment to make provision for operation on either direct or alternating current. Furthermore, as it was not considered advisable to use a high-potential trolley within the limits of the town of Rushville, it became necessary to provide for the use of two alternating-current trolley voltages. The main portion of the trolley circuit will be fed with 3,300-volt, single-phase, alternating current. The total arrangement, therefore, includes operation at 550 volts direct current within the city limits of Indianapolis and 550 volts alternating current in Rushville, and 3,300-volt, alternating current on the other sections of the line. Because of this complicated service, it seemed advisable to pass by the attractive and economical features of control by induction regulators and to adopt the rheostatic system on account of its simplicity and adaptability to both alternating and direct-current operation.

The car equipment includes four alternating-current, commutator-type, series-wound railway motors, rated at 75 hp each; one main auto-transformer wound for a primary potential of 550 volts, 1,650 volts and 3,300 volts, and for a secondary potential of approximately 250 volts; reversing switch; motor cut-out switch; commutator or change-over switch, to throw the equipment from alternating current to direct current, and vice versa; a complete unit switch system of multiple control, with two operating controllers arranged for the operation of the cars either singly or in trains; rheostats for use on either alternating or direct-current circuits; air compressors direct-connected to both an alternating-current and direct-current series-wound motor; air reservoirs; two sets of storage batteries, consisting of seven cells each; complete Westinghouse air-brake equipment, with control valve on either platform; complete hand-brake equipment, with controlling lever on one platform; one wheel trolley for low-potential service, and one bow type trolley for high-potential service. The motors, which are of the standard Westinghouse single-phase type, are rated at 75 hp each, and are geared for a maximum speed of 45 m.p.h. for local service.

The circuits of the controlling equipment and the four driving motors of a single car are shown in Fig. 8. The controlling is done entirely by relays, for which purpose there is used a cable containing eleven conductors running the full length of the train. The controlling circuits are electrically distinct from the main operating circuits, and obtain their power from a storage battery. There are two master controllers on each car, one at either end thereof. Any one of these at any point throughout the train serves for connecting the conductors of the cables in the proper method for energizing the relays in the order desired.

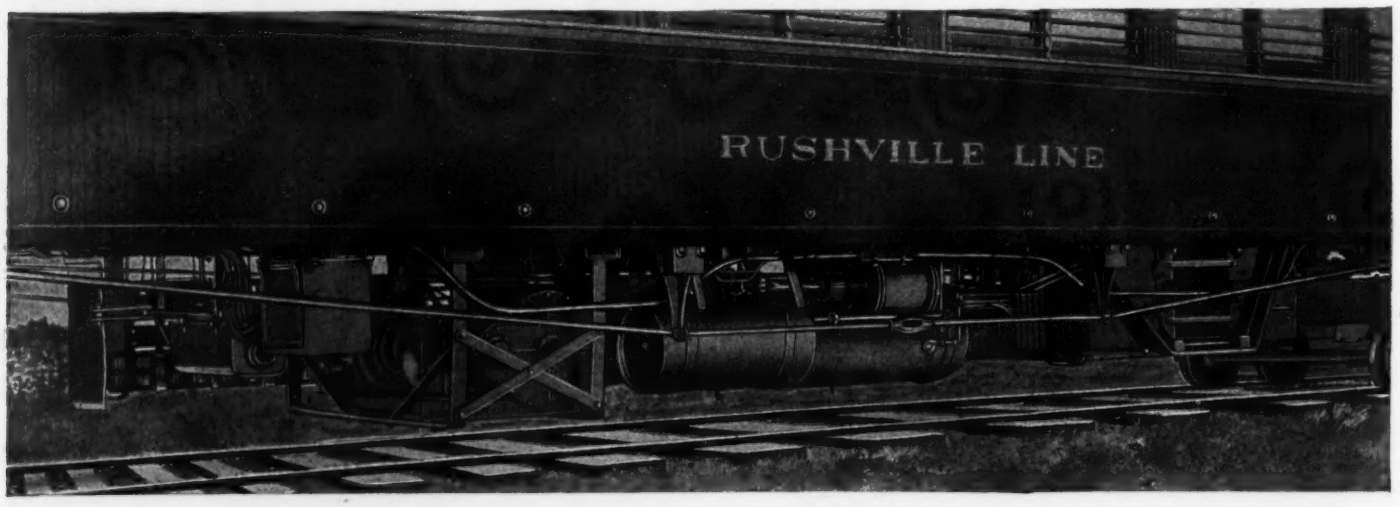


FIG. 9.—VIEW OF APPARATUS UNDERNEATH CAR.

The main operating circuits may receive power from any one of three sources, entirely distinct as to voltage or character of current. Thus, the supply may be at 3,000 volts alternating, 500 volts alternating or at 500 volts direct current. For direct-current operation the four propelling motors are connected in series and subjected to a plain rheostatic control for acceleration.

For alternating-current work, there is installed a main auto-transformer having two primary feeding taps, at points corresponding to 3,000 volts or 500 volts for normal magnetization of the core. When the supply voltage is 3,000, the former of these is used, while for 500-volt supply the latter is employed.

Two distinct taps from the auto-transformer are used for current for the motor. The voltage impressed upon the motors is given one or the other of a lower or higher value, according to the speed desired. Thus, without series paralleling the motors the same effect is produced by merely varying the active e.m.f. at the motor terminals. Under all conditions of alternating-current operation all of the motors of each car are connected in parallel, and for each of the two values of voltage simple rheostatic control is used.

For both direct and alternating-current operation, the lighting circuit is supplied with current at 500 volts, either directly from the

continuous-current circuits or through a special auto-transformer from the alternating-current circuits. As is the case with the main power transformer, the lighting transformer has taps at 3,000 and 500 volts, respectively. The lamps are supplied from the 500-volt tap. At the 100-volt point there is placed an additional tap for supplying current to a compensated alternating-current series motor for operating the air pumps. It will be observed that the grounding point of the lighting transformer is at the neutral e.m.f. point of the alternating-current motor. An entirely distinct pumping equipment is operated by a small series-wound, 500-volt, direct-current motor, which is controlled automatically by the air pressure.

The unit switch system of multiple control as adopted is the standard Westinghouse equipment modified to suit the double operation by alternating and direct current. The unit switches are arranged in groups, one of eight units and one of four units, which are mounted under the floor of the car. They are operated by compressed air, which, in turn, is controlled by magnet valves actuated by current from the storage batteries. The operating controllers are mounted one upon each platform, and are very small and compact, as may be seen from the accompanying illustration. The reverser, which is also illustrated, is of the reciprocating type, generally used with the Westinghouse system of multiple control.

The main auto-transformer is of the shell form, air-cooled type. Before shipment it was subjected to a test of 10,000 volts between winding and iron, and was operated at double potential for ten minutes. It is designed for operation at 25 cycles, a frequency which has been adopted as standard for single-phase railway service.

The illustration given of the bow trolley shows the standard form of collector designed for high-potential alternating-current circuits. The trolley is mounted upon a thoroughly insulated platform, and is raised, lowered and controlled by the motorman by means of compressed air. There is, therefore, no danger at any time of contact with live parts of the trolley. The bow carries a large, flat aluminum shoe, which makes contact with the under side of the trolley wire. For low-potential service, whether alternating or direct current, a modification of the ordinary trolley is provided, as the bow type could not be used in the city of Indianapolis.

The entire electrical equipment of these cars was installed under the supervision of Sargent & Lundy, of Chicago, who had charge of the design of the entire railway system, and of its construction and equipment.

Electrical Thawing of Frozen Water Pipes.

BY M. A. SAMMETT.

THE application of electric currents as a thermal agent in thawing frozen water pipes is meeting with great success, and the increasing demand for thawing transformers has brought out a variety of special apparatus designed by various manufacturers for this particular service. There can be no doubt that alternating current furnishes a most easy and efficient means of restoring the water supply. Considering the fact that the time required for the work is only several minutes, that no excavations are necessary, and that the piping is left intact, the method has all the desirable features and needs no recommendation.

The various transformers placed on the market seem to have one objectionable characteristic, namely, the manner of regulating the secondary pressure. Of the different means for accomplishing this, in every instance the transformer capacity is reduced. This is true when the secondary voltage is regulated by a reactive coil inserted in series with the secondary coil, or when the voltage is controlled by an adjustable shunt in the core. The same holds true when taps are brought out for obtaining variable voltages. It is this drawback which led to the development of a type which will allow in every instance the use of the full capacity of the transformer at various combinations of voltages.

For this purpose a transformer was so designed as to allow either series or multiple connections of two primary coils, and three combinations of four secondary coils (Fig. 1). The current capacity of each secondary coil is 200 amp. The secondary pressure is 12.5 volts per coil with primary coils in series, and 25 volts per coil with primary coils in multiple.

The combination of the secondary coils is as follows: All secondary coils in series give 200 amp. at either 50 or 100 volts; coils in series multiple give 400 amp. at either 25 or 50 volts, and all coils in multiple give 800 amp. at either 12.5 or 25 volts. As the transformer is to be operated in some cases with the two primary coils in multiple, it had to be designed for comparatively low magnetic density so as to keep the iron losses moderate at the higher induction.

Whenever high voltages are to be made use of it is generally a case of a long pipe of small cross section, where 200 amp. are quite sufficient to melt the ice. Whenever a large main is to be thawed

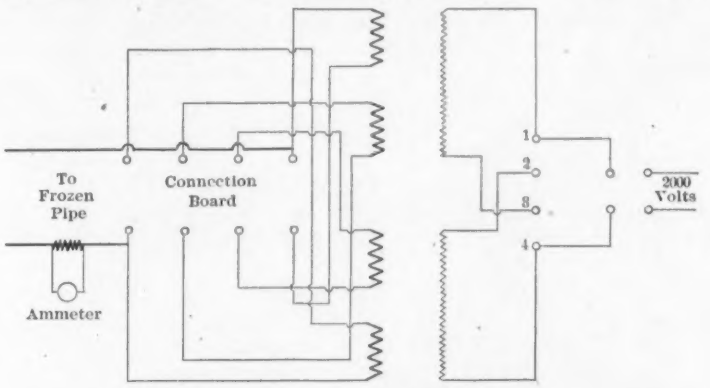


FIG. 1.—DIAGRAM OF CONNECTIONS.

out, requiring a low voltage and a high current, the combination giving 800 amp. normal will do the work. In every instance liberal overloads may be allowed, as the transformers operate intermittently and there would be no trouble from carrying double current for a period of one-half an hour.

The Montreal Light, Heat & Power Company has in service at the present time four transformer outfits similar to the one shown in Fig. 2. Each transformer has a capacity at normal rating of 10 kw, and is of the oil-insulated type. The weight of the transformer complete, without switches, is 600 pounds.

In the work of thawing service pipes of ½ in diameter about 200 ft.

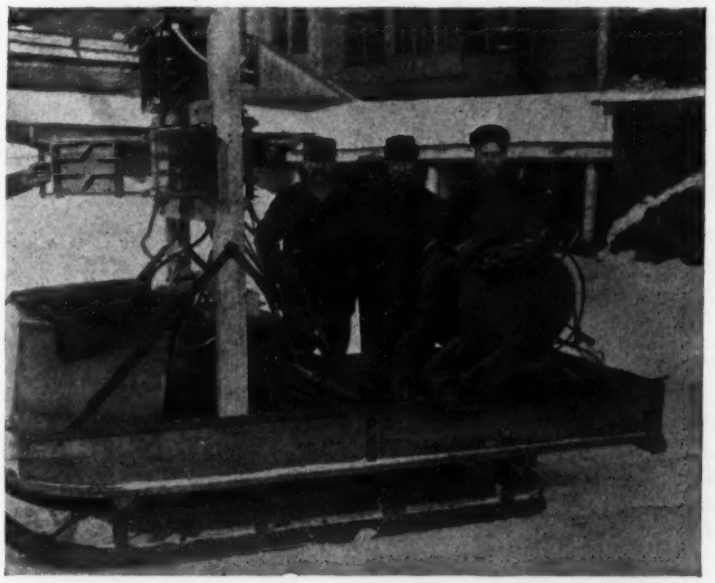


FIG. 2.—TRANSFORMER AND SWITCHBOARD.

long from two to three minutes are sufficient. In some instances only fifteen seconds were required for restoring the water supply, and in a single day as many as 40 cases were successfully attended to.

The secondary switching service consists of a connection board which has eight studs joined to eight leads of the four secondary coils. The switches engaging with the board give the desirable combinations of the secondary coils, and in most of the work on service pipes the 50 and 25-volt combinations were used very effectively. The switches are made of heavy copper bars engaging with the studs and so arranged as to use only one combination at a time. A current transformer and ammeter are used on the secondary side to indicate the current passing through the pipe.

The possibility of having available the full capacity of the transformer at different voltages makes the 10-kw transformer meet a diversity of requirements, and offers a very flexible arrangement for different conditions.

The Application of Electric Motors to Machine Tools.

By George T. Hanchett.

THIS subject is a problem which is daily engaging the attention of engineers to an increasing degree and is one deserving of their best attention. To discuss the matter in a general way, as a preliminary premise it is to be assumed that a satisfactory application of sufficient power and sufficient speed range has been secured. It is then interesting to consider to what degree the application should be carried, where to cease the direct application of motors to tools, and where to begin group driving.

It has been common to argue upon this proposition from a point of power economy, and the results of such a deduction always show that it is well to begin group driving as soon as the powers of individual tools have dropped to 1½ hp or less, the situation, of course, being influenced by the way it is customary to use the tools in the shop in question.

The advantages of driving tools directly by motors are the following:

1. Saving in time. 2. Increased output of the tool. 3. Convenience in shop arrangement. 4. Saving in power.

These items are placed in their order of importance. The first three items pertain to saving in time, the last to saving in power. Modern machine shop practice has shown that machinist's time at $3 per day is a more important item than electricity at 10 cents per kw-hour, and the comparison of these items is so marked that in the writer's opinion it is good practice to carry motor-driven machine tool driving to a far greater extent than has commonly been considered good practice. The motor-driven machine tool permits of being placed in any position without regard to counter-shafting, and therefore in the best position with reference to light. An item of even greater importance is that each man's tool may be placed in close proximity to his bench, so that it is but a step from one to another. Much time is lost in walking about a shop and in carrying heavy work from a machine to the bench, or vice versa.

The absence of counter-shafting also enables an elaborate trolley system of I beams to be suspended over the tools so that heavy work can be moved from place to place and swung into the lathe or planer with great facility. It is, furthermore, possible to group tools in such a way that progressive processes will be possible; that is to say, the piece of work can pass from shaper to lathe and to drill press in such an order that the least time is consumed.

The convenience of manipulation now being apparent, it is well to spend a few moments' consideration upon the expedition with which the work can be performed once it is in the tool. It is a notable fact that machine tools almost without exception are under-belted; that is to say, the belt width is not capable of driving the tool with all the force that the machine itself will stand. Some tools, indeed, are more favorably belted than others, but the exigencies of installing a belted outfit often require that the belt be unfavorably short or with the tight side in the wrong position or at an improper angle—very often directly vertical, in which position a belt has minimum power. With the direct application of a motor to a tool, which should always be by some positive drive, such as a chain or gear in order to eliminate the belt difficulties just mentioned, the motor may be proportioned so as to develop all the force that the tool will endure, and therefore much saving in time is gained by taking the heaviest possible cuts. Furthermore, the proper application of motors to tools has unquestionably developed the fact that work of large diameter can be handled in machines that were totally inadequate for the purpose before, the range of the machine being thus enhanced.

Speed of cutting is another item to which little attention has been paid in the past in the average machine shop. The machinist steps his belt until it has a speed which appears to him "about right," and then finishes the entire job at that speed. If a lathe, the speed may be right on the large diameter and altogether too slow for the small diameter, but the time consumed in stopping the lathe and changing the belt is an item which usually constitutes an inconvenience so great that it is neglected. With the motor-driven tool the machinist can start the small diameter cut at high speed and as the tool feeds outward the controller can be stepped down, and this, combined with the possibilities of heavier cuts, very frequently reduces the time 50 per cent.

The saving in power is an item which comes up for consideration last. Taking a plant of 100 kw capacity as a convenient figure and starting from the engine shaft, we have a loss of efficiency in the dynamo of 10 per cent., a loss in the wiring of 5 per cent. more, and an average loss in the motors of about 15 per cent., considering the fact that they are very frequently run at low speed and under unfavorable conditions. This makes a gross total loss of 30 per cent. from engine to tool. As a well-designed system of shafting will transmit from engine to tool at a loss of 40 per cent., it is very plain that if every tool is in continuous operation the saving in power does not justify the added investment of installing direct drive. That this is a fact the writer can testify by personal experience by frequent wattmeter measurements on two shops very nearly alike in gross total power required, and both running continuously, one being driven by a single motor and a system of counter-shafts, and the other directly by individual motors. Fortunately for the proposition of power saving, the exigencies of a machine shop usually demand that only a portion of the tools be operated, and this requirement causes the direct-driven shop to gain. The counter-shaft item is a constant number of kilowatt-hours throughout the day; that is to say, the 40 per cent. is a practically constant loss. With the motor-driven shop on the other hand, the line loss and the motor loss is a variable and rarely reaches the maximum, and assuming that one-half the tools in the shop are in operation, the all-day efficiency of the motor drive can be safely figured as 80 per cent., as against 60 per cent. for the belt drive.

In finally deciding the matter, a great deal of practical sense is necessary. The various advantages of machine tool drive—and it may here be properly reiterated that saving in power is one of the least of these—should be carefully considered and equated against the added investment, which it is safe to assume is 200 per cent. greater than with belts and counter-shafts, from an investment standpoint. From a maintenance standpoint, however, it will usually be found that a properly designed motor-driven installation will show a saving over the belt-driven proposition; for the attention that belts and counter-shafts require, the wearing out of belts, their breakage and the loss of time thereby entailed is greater than will obtain with the motor-driven proposition.

It is practically an impossibility to say in a general way where individual drive should cease and where group driving should begin. Every shop presents a different problem. It is usually safe to drive groups of like tools which are being constantly used, such as in brass departments where many small parts are being drilled and tapped continuously by cheap help, partly for the reason that there is no necessity for great power at the tools, partly because individual drives would result in undue expense due to the large number of small motors, partly because the saving in power is microscopic, due to the fact that the department is running continually, and partly because shop arrangement is not of paramount importance, and the help in such a department usually stay constantly by the tool and pass the work from the box on one side of the tool to a box on the other and do practically no bench work. On the other hand, very large tools and groups of tools which are operated by expensive machinists who alternate from tool to tool and from tool to bench, can almost always be profitably driven by direct drive. In any of these cases, however, special advantages due to the situation may arise which will materially alter matters; therefore, each case must be treated by itself.

Admitting, therefore, that motor drive for machine tools is good practice, and admitting still further that much greater subdivision than has often been recommended is also good practice, it becomes important to consider the system of variable-speed control. It is, furthermore, a fact that the only practical motor to use in the present development of the art is a direct-current motor, although the next few years may see radical changes. The speed of a direct-current motor can be varied in several ways, the most prominent of which are the following:

1. By varying the armature voltage. 2. By varying the strength of the field. 3. By varying the number of effective conductors on the armature.

All of these methods are employed in motors designed for driving machine tools.

The controlling of a motor by armature voltage with the ordinary well-known means of inserting a variable resistance in series with the armature, is applicable to machine tool work only in special cases. For rotating machinery it is not at all suitable for the reason that the actual voltage upon the armature, and therefore its speed,

depends upon the drop through the resistance, and this in turn depends upon the load the motor may be carrying at the time. If, therefore, the motor be driving, for instance, a lathe, it will be found that when the tool is not on the work the speed of the motor will rise, due to the reduction of drop in the controlling resistance, and the motor will "lay down" under load. Of course, it is possible to "notch up" after the tool is well started in the work, but sudden changes of speed with different thicknesses of cut are prejudicial to the preservation of tool points, and it is impossible to do close work under such conditions.

For reciprocating machinery such as shapers and planers, control by armature resistance possesses an advantage. In such tools the tool enters the work at the beginning of the stroke, where the speed is, by reason of the construction of the machine, very moderate, and as the tool speeds up by reason of the mechanism, the motor speeds down by reason of the load, and the controller enables the equating of these two quantities very readily. On the return stroke where the machine is running light, the increase of speed due to reduction of resistance drop is a positive advantage as it accentuates the quick return motion, which is always desirable.

For the broad general case, control by armature voltage requires a number of constant potentials, any one of which may be impressed upon the motor armature. These are usually obtained by means of a balancer containing two or more machines in series and connected directly across the line. If the voltages of these machines are properly chosen, a very satisfactory series of speeds can be obtained by bringing three or four wires, as the case may be, at joining points on the balancer system and connecting the motor to these wires in the order of magnitude of the potentials between them. With a three-machine balancer a reduction ratio of 6 to 1 can be readily obtained, and such balancer systems are to be recommended where motors are applied to existing machine tools, and where there is only one mechanical speed ratio between the driven spindle and the motor.

In cases where the motor and tool are built together and where change of gears between the motor and tool are provided, a lesser speed range of the motor is permissible, and a two-machine balancer system giving a ratio of 4 to 1 or 3 to 1, is simpler and in some cases more desirable.

With a system of armature control, the motors must be so chosen that full field and full armature current will produce a torque as great as will ever be required upon the tool to be driven. This has the effect of making the motor somewhat large, for the heavy cuts are made at slow speed and full torque is required. The high speeds are used for light cuts where full torque is almost never required, and consequently though the motor practically never operates at full speed and full torque and therefore at full horse-power, it must possess both the high speed and heavy torque, and consequently must be a large machine.

The method of field control from a theoretical viewpoint is practically ideal. In such a motor the horse-power is constant, the heavy torque obtains at the low speed, and at the high speeds the torque is less, but owing to the nature of the work heavy torque at those speeds is not required. The difficulty of such a system is that of obtaining sufficient range of speed without commutator pyrotechnics. The average direct-current motor on the market as designed for ordinary purposes can usually be varied about 25 per cent. in speed by means of field control without serious trouble at the brushes, but even the first-class makers are inclined to hesitate when larger field control is proposed. When ranges of 2 to 1 or greater are desired by means of field control, recourse must be had to special design and motors are now produced for which great claims are made. Some of them are undoubtedly able to control in a practical way within these limits, and others are not, and so a great deal of varied experience with reference to field control has been had among consulting and constructing engineers.

It should be said that most motors having a field control as wide as this are of necessity considerably larger than a normal motor of the same rated horse-power, and it will usually be found in figuring a field-control motor versus an armature-controlled motor, that there is little to choose between the prices of the two. The armature-controlled motor is a great deal larger than it really needs to be from a power standpoint by reason of the torque conditions impressed upon it. The field-controlled motor, although rated at a much lower power for the same work, is much larger than an ordinary commercial motor of the same capacity because of the peculiar precaution necessary in the design; and when the expense for the added material and workmanship and the natural increase in price over and above the commercial motor, which is legitimately due to the lesser demand, is paid, there is little gained from a financial standpoint in adopting the one or the other system. The balancer of the armature-control system is an item which will, however, figure as an extra.

The field-controlled motor is susceptible of a very much finer gradation of speed than the armature-controlled motor and is desirable by reason of this feature. It must not be forgotten, however, that the field-controlled motor must be selected with great care. A motor for driving machine tools is subjected to rough treatment. Sudden application of full load and instant reversal are often demanded, and against such treatment the armature-controlled motor with constant field with great strength offers good security. The field-controlled motor must be cleverly designed in order to stand such treatment, and the fact that many motors having large claims are made incapable of such manipulation, renders greater care necessary in selecting a field-controlled system.

The third method of controlling the speed of motors is by varying the conductors of the armature, and this is done in some cases by providing the motor with two windings and two commutators which can be used singly, in multiple and series if they are alike, and in series alone if they differ. This may be perhaps considered as a modification of control by armature voltage. The number of speeds is more or less limited, and such a system would, in some cases, have to be supplemented by a field control.

Besides these fundamental systems there exist combinations of all of them, the usual plan being to adopt an armature voltage and field control combined. This provides variable speeds between the notches, the field control being limited, and by this limitation reduces to a certainty all elimination of trouble that may arise from weak fields. A combination of field control with the ordinary commercial three-wire system has been experimented upon, and if brought to a perfect condition offers some conspicuous advantages, for it presents the conveniences of both systems and eliminates some of the objectionable features. No balancer is required, the field control is limited, and the conditions which govern the selection of the motor enable a machine to be used somewhat cheaper than either system alone would require.

To sum up the situation, it may be stated that the armature-controlled system by balancer, though somewhat complicated, gives exceedingly satisfactory results, and almost any motor will work upon it. Wide range by field control violates some of the old standbys in dynamo designing, but it is very evident that great advances in the art of field-controlled motors have been made, and it is not at all impossible that some of the recent designs may solve the general problem.

Power for Shafting and Tools.

Some tests made in Great Britain on the relative amount of power consumed in shop shafting and machines driven therefrom are interesting as showing the economy incident to the motor drive. In the case of a planing machine planing a 1-in. plate 14 ft. long, the shafting absorbed 4.95 hp, and the tool .57 hp, running light, and 2.57 hp when planing a 1-in. plate 14 ft. long. When the same machine was planing a 5/8-in. plate the horse-power absorbed was .98. In the case of a radial drill drilling a 1 1/16-in. hole in cast iron the shafting absorbed 4.82 and the machine 1.87 hp. In measurements taken in connection with a shafting lathe, the power for running the shafting was 7.25 hp and .49 hp with the lathe running light; with one tool taking 11/16-in. cut from a flange, 1.83 hp was absorbed, and with two tools cutting on opposite sides from the flanges, 2.54 hp was required. The amount of power found to be necessary for working several different machines was as follows: Punching 3/4-in. holes in 1/2-in. plate, 3.94 hp; running a circular saw 2 ft. 8 in. in diameter and 3/16 in. thick, 2.75 hp; running a large lathe light, .4 hp, and running it loaded, .9 hp; running a jeweler's lathe light, .4 hp, and when loaded .6 hp; running a grindstone light, .6 hp, and with load, 1 hp. A 15-in. planer with 75 ft. of 2 1/2-in. shafting and ten bearings absorbed 4 hp running light and 6 hp when planing 3-in. yellow pine. A 20-in. circular saw running light absorbed 2.7 hp; cutting 3-in. yellow pine the horse-power became 6 and 7.4 hp when cutting spruce.

Individual Motor Drive in a Type Foundry.

THE factory of the American Type Founders' Company, at Communipaw, N. J., affords a striking illustration of the advantages attending the use of individual-motor drives for small machines. All of the power for operating the factory is obtained through electric motors, and, with the exception of a portion of the early installation of machine tools, which are placed in groups and driven by belts from short line shafting, each machine is equipped with its separate motor, which is disconnected completely from the source of supply of current when the corresponding machine is not in use. The total number of motors installed is in the neighborhood of 140, all being of the direct-current type.

In the extension of the equipment, which is taking place at the present time, all line shafting is being omitted, while, so far as practicable, the former method of group driving is being abandoned in favor of the operation of each machine by its own motor. One cannot but be impressed with the degree to which the individual-motor method of driving is being here carried. In one instance, particularly, is this to be noted. A former equipment, which consisted of a single motor driving a miniature shaft to which were belted three turning heads for sharpening tools for matrix engraving machines, each being no larger than a jeweler's lathe, is being dismantled so that each sharpener may be driven by a separate 1/7-hp motor. Economy of power, though of considerable importance, has not been the sole determining factor leading to the abandonment of group driving. The ability to locate each machine most advantageously with regard to its specific duty, and the elimination of belting which obstructs the view and occupies valuable space, have all been given due weight in making the various changes.

All of the motors in use are of the direct-current type, operated at a normal voltage of 115. A few are compound-wound, many are shunt-wound, constant-speed machines, while a large proportion of the equipment consists of shunt-wound, variable-speed motors.

As the name of the company implies, its principal business is the manufacture of metal type. While many old-style type casting machines are yet in use and rendering good service, the main part of the type foundry equipment consists of modern Barth automatic casting machines, each being driven by belt from a separate shunt-wound motor. Of these, more than 60 are now in use, while others are being installed as rapidly as the type casting machines can be obtained. The capacity of the individual motors in use with the casting machine is ¾ hp for the major portion of the equipment. Ten of the machines now in service or in process of erection are driven by 2-hp motors. (See Fig. 2).

Although in general each size of type requires that the type machine be run at a definite speed, it is imperative that a wide range of speed be available so as to render each machine universal in its application to the numerous sizes of types manufactured, and the finest gradations of speed variation are desirable for the highest character of output. In order to meet these requirements, there has been installed a type of variable-speed motor, in combination with cone pulleys having four steps. These motors are Stow multispeed machines, back-geared to the driving cones. As is well known, this type of motor has a bipolar field completely enclosed. Each is constructed with a simple plunger within the magnet core for the purpose of varying the reluctance of the magnetic path. By this means there may be obtained any speed whatever within the range for which the machine has been designed, without sparking at the commutator. In combination with the four-step cones, the speed range of the casting machines is from 12 to 200 cycles per minute, or in the ratio of 1 to 16. Since for each adjustment of the belt on the cones the range of speed due to the variation of the field strength of the motor is more than 125 per cent., there is a considerable overlapping of range for adjacent steps on the cones, and no difficulty is experienced in selecting the proper step for the speed desired.

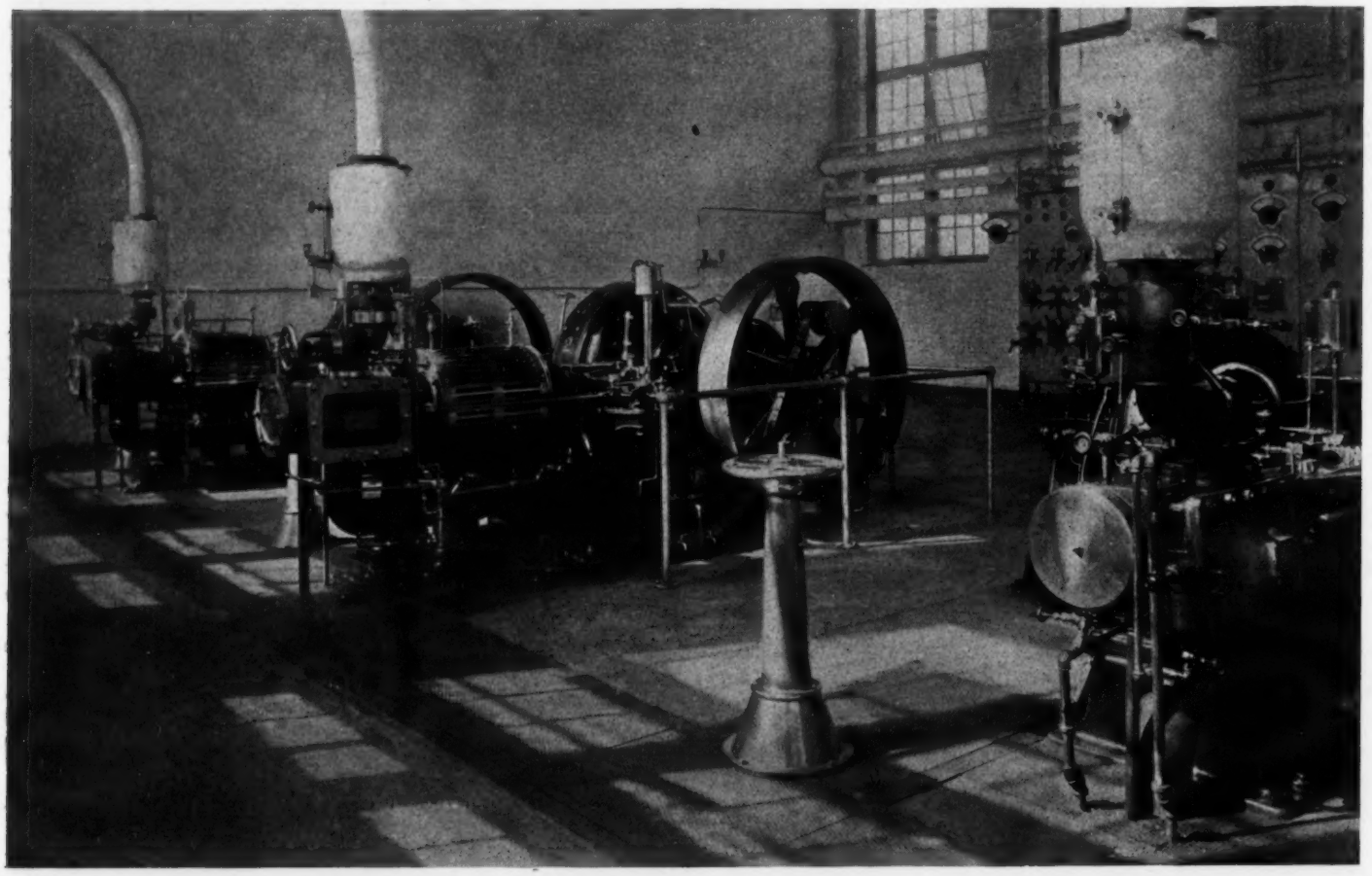


FIG. 1.—INTERIOR OF GENERATOR ROOM.

The type metal is kept in a molten condition by means of gas and compressed air. Two Clayton compressors deliver air at a pressure of about 10 pounds per sq. in. to two tanks from which it is piped to the various points where needed. Each compressor is connected through a Renolds silent chain drive to a 7.5-hp General Electric motor operating at 815 r.p.m. A single compressor outfit is shown in Fig. 3. Although the ratio of the clearance space in the compressor cylinder to the effective stroke of the machine determines the maximum pressure attainable in the tanks, each tank is provided with a blow-off valve operative by any excess pressure due to accidental causes. The compressed air performs an additional service, in that it is particularly advantageous for blowing chips from the various machines, and for cleansing purposes.

For the preparation of the matrices and punches, there are in use nine punch and matrix engraving machines, each being driven by a 1/7-hp Holtzer-Cabot motor running at 2,300 r.p.m. In the matrix machine, the engraving tool itself is connected to a flexible shaft, which is driven by a small circular leather belt at a maximum speed of about 8,000 r.p.m. The tool, both as to its position on the matrix and as to its speed of cutting, is under perfect control of the operator, the electric motor drive and flexible shaft combination having been found especially well adapted to this work. For the purpose of grinding the engraving tools, three miniature sharpeners are driven from a counter shaft by a small Eck motor. As mentioned previously, these sharpeners are being arranged for individual motor drives. In the room set apart for the fitting of the matrixes are installed saws and trimming tools for the finishing of the product. These machine tools are operated by Sprague motors, the sizes of which vary from ⅓ to 1 hp. The trimming tools are direct-connected, while the other machines are belt driven by individual motors.

In the main mould-machining department of the factory, the tools are arranged in two groups driven by separate 5-hp General Electric motors. These machines, which constitute the earlier equipment, are in almost constant operation throughout the working day, so that the recognized advantages of individual motor drive are not sufficient to justify the immediate elimination of the belting and line shafting. The additional equipment, which is now being in-

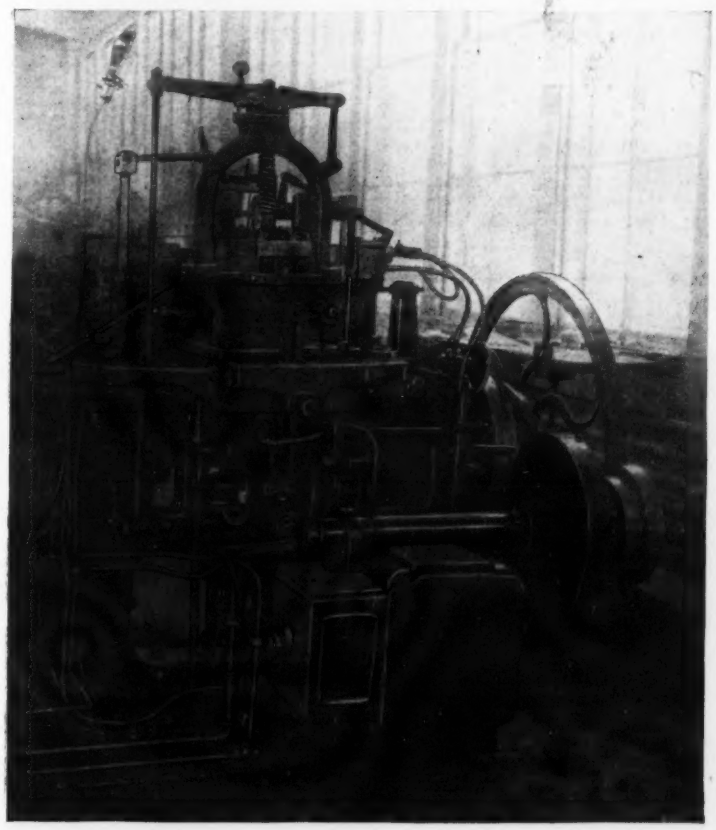


FIG. 2.—MULTISPEED MOTOR DRIVING TYPE-CASTING MACHINE.

stalled, will be operated by individual drives and Stow multispeed motors will be used for this purpose. A special machine tool, which forms part of the new installation, is a double-headed trimmer belted to a Connecticut Dynamo & Motor Company's 3-hp motor, which is suspended from the ceiling. This method of driving was adopted for this special case on account of the comparative ease with which the required equality of speeds for the separate heads could be obtained by vertical belting.

A modest but important part played by electricity in the machinery department is in the production of electromagnets used as substitute for clutches on the milling machines. The faceplate of the machine is divided into two interweaved sections, one magnetically a north and the other a south pole, the space between the sections being filled with a strip of zinc. Small pieces of magnetic material when laid on the faceplate are held firmly in place, while an emery stone serves for dressing them to the required size. The use of mechanical clutches for such miniature pieces would be exceedingly inconvenient. The electromagnets, however, give perfect results, a large number of small pieces being handled simultaneously when they are of a uniform size. For the purpose of removing every trace of magnetism from the completed pieces, they are drawn across the face of an alternating magnet operated by power from the direct-current circuit.

Although the company is not engaged commercially in the competitive printing business, it maintains a well-organized and equipped printing establishment for its own private use. The installation includes seven cylinder presses belted to Holtzer-Cabot motors. Of

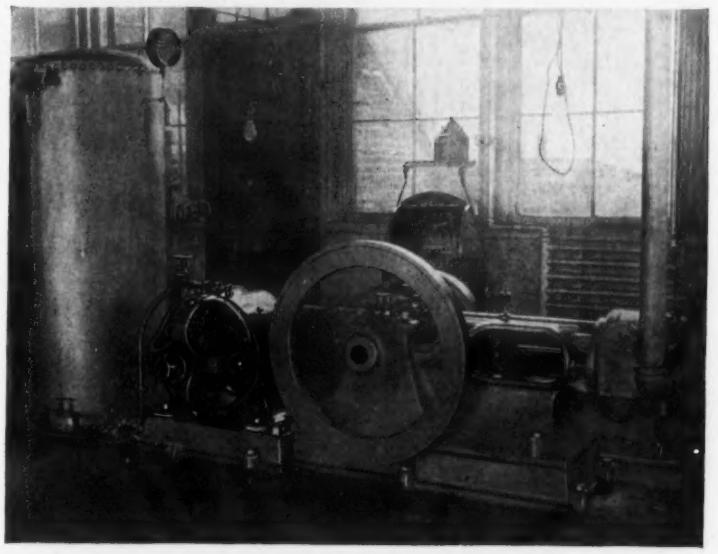


FIG. 3.—MOTOR-DRIVEN AIR COMPRESSOR.

these, five Whitlock machines are driven individually by 3-hp motors, operating at 400 r.p.m., and two Cottrell-Stop presses are connected to 3-hp motors. Three presses made by the Miehle Manufacturing Company are operated by belt from Connecticut Dynamo & Motor Company's 3-hp motors. The particular feature worthy of note in connection with these presses resides in the method employed for rendering the motor equipment as compact as possible. Instead of using a standard motor located on the floor adjacent to the press, as has been the usual practice, the present motors are provided with special end bells having extension bearing caps, and are placed within the framework of the press proper, as seen in Fig. 4. This

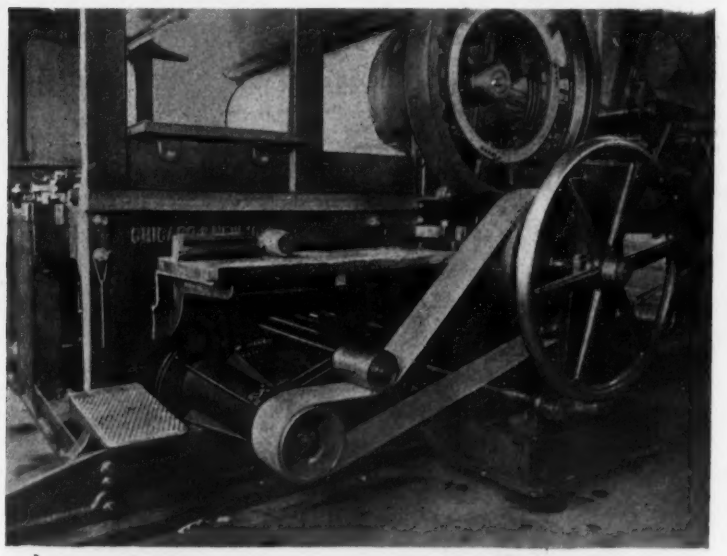


FIG. 4.—VIEW SHOWING SPECIAL END BELT ON PRINTING PRESS MOTOR.

method results in a considerable economy of space, and obviates the necessity of an extra bearing.

The motors for the presses are provided with Carpenter type of starting resistances with no-voltage releases, and complete Cutler-Hammer controller outfits. In the latest type of controller there are available 15 forward and 3 reverse speeds. The controller mechanism and contacts are completely enclosed and protected from dust, an opening for the handle being made in the side and not at the top as with the former models. The presses may be stopped instantly from several points by means of push buttons.

Five 1-hp Holtzer-Cabot motors drive separate Universal presses, while an equal number of Chandler & Price Gordon machines are belted to ¼-hp motors of the same type. In the pressroom, which is located on the top floor of the main building and supplied with an abundance of light both from the sides and from above, is installed the usual auxiliary apparatus found in printing establishments. A Boston stitching machine and a rule-cutting saw are each driven by a ⅙-hp Holtzer-Cabot motor. Two paper cutters are separately belted to 2-hp Holtzer-Cabot motors, which run at a constant speed of about 800 r.p.m. The minute fluctuations of power demanded by the cutters in no way interferes with the brilliancy of the incandescent lamps, which are supplied through a separate circuit from the same generator.

In the wood-working department, which is an essential adjunct to the self-contained factory, are installed a 5-hp General Electric motor, equipped with Cutler-Hammer rheostatic starter with no-voltage release, for the operation of a short line of shafting, and a 2-hp Sprague motor belted to a Royle carpenter saw.

The factory building has been designed with especial reference to the handling of the raw material and the finished product. The outer walls contain the largest possible area of glass consistent with the required strength of the building, while the machinery for those processes which require the most illumination has been placed on the top floor so as to receive additional light through the roof. Material is sent from one floor to another by means of three automatic lifts, each operated by a Crocker-Wheeler 3-hp motor geared to the hoisting mechanism. At each of the three floor landings is placed a series of push buttons numbered according to the separate landings. The pressing of any one button sends the lift to the corresponding landing, provided all doors are closed. There is a mechanical device interlocking with the catch at each door, which prevents any door from being opened until the lift is at that landing. The opening of a door breaks the electric circuit to the motor and insures that the lift will remain stationary until the door is closed. These lifts have proved very valuable in facilitating the handling of light materials.

Three freight elevators, built by the Marine Engine & Machine

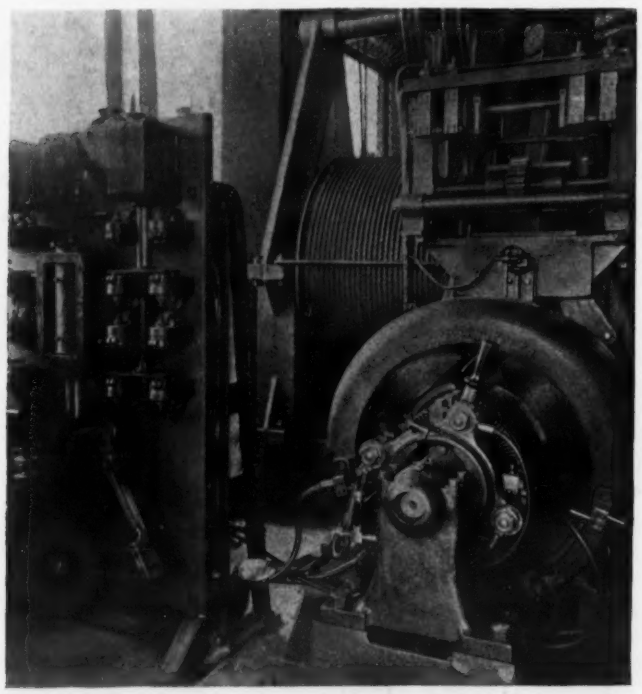


FIG. 5.—20-HP ELEVATOR MOTOR AND CONTROLLER.

Company, Newark, N. J., serve for transferring heavy machinery and material in bulk from one floor to another. These are separately operated by 20-hp Crocker-Wheeler motors. An elevator motor equipment with controlling board is illustrated in Fig. 5. A 6,000-pound automatic lift is placed in the smelting room, which is under the same roof with the power house, for elevating hand cars from the lower level of the smelting room to a track connecting with the main floor of the factory. The lift (Fig. 6) is driven by a 12-hp Crocker-Wheeler motor, which runs at 870 r.p.m. A 5-hp General Electric motor, which is belted through counter shaft to two type metal mixers, completes the electrical motor equipment of the smelter room.

Although the service required of almost every motor throughout the factory is such as to call for a fluctuating amount of power, the large number of the motors in use causes the resultant demand for power to be more or less constant, even when the elevators and lifts are placed in operation, the compound winding on the supply

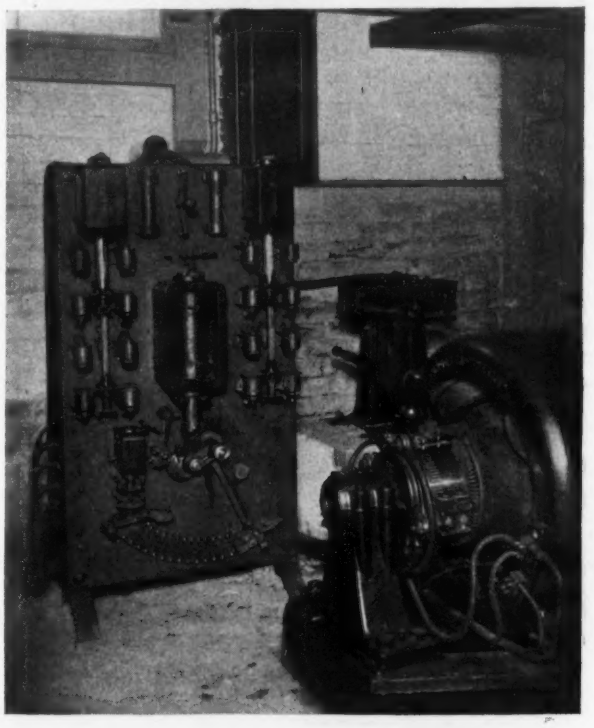


FIG. 6.—12-HP MOTOR EQUIPMENT FOR AUTOMATIC LIFT.

generators being such as to maintain a fairly constant e.m.f. on all lighting circuits. For convenience of control, as well as for the purpose of minimizing the effects of the fluctuating motor loads, the circuits to the lamps are separate from those to the motors within the main building, although all circuits are supplied through common feeders from the power house. In every instance, whether the power consuming device be a lamp or a motor, the distributing circuit is carried in iron conduit, while the wiring at each machine is amply protected by insulating covering.

For the purpose of maintaining the electrical illumination when the generating equipment is at rest, a storage battery of 70 11-plate Electric Storage Battery Company's cells is installed in a special battery room adjacent to the power house. Ten of these cells are arranged for end cell control, so that the attendant can regulate the delivered voltage at will. For charging the battery a set consisting of a 120-volt, 45-amp. motor, direct-connected to a 50-amp., 60-volt generator made by the Electro-Dynamic Company, is placed in the engine room.

The generating equipment consists of two 75-kw, 125-volt, compound-wound, direct-current generators, made by the C. & C. Electric Company, of New York, direct-connected to tandem compound engines made by the Skinner Engine Company, Erie, Pa., and one similar C. & C. generator of 30 kw capacity, direct-driven by a simple Woodbury engine built by the Stearns Manufacturing Company, Erie, Pa. A noteworthy feature of the switchboard consists in the use of three Thomson integrating watt-hour meters, one for each generator, for determining the amount of service given by each engine equipment. The circuit-breakers upon the board are of the Victor single-pole switch type, made by the F. A. La Roche Company, arranged in pairs, so that, if one switch is in place, when the second is held closed by hand thus completing the circuit on an overload or fault, the first switch will open. Under normal operation both switches of a pair open simultaneously if either one trips its breaker. A Bristol recording voltmeter, which is conveniently arranged on the switchboard, serves to insure that the e.m.f. delivered at the factory will be kept at the required value.

Steam is used both for the generation of current for power and illumination and for supplying heat to the buildings when needed. The boiler house contains at present two 150-hp Heine safety boilers equipped with Treadwell rocking grates, the fuel being buckwheat

anthracite coal. In investigating the advantages of mechanical stokers, it was concluded that the number of boiler room attendants would be the same with or without the stokers, and that an actual loss for equipment and repairs would be involved in their installation, so that the boilers are fired by hand. The boiler auxiliaries are operated directly by steam, with the exception of a small centrifugal pump, which is used for raising water from a waste and drain pit, and which is mounted on a common bedplate with, and direct-connected to, a ½-hp Lundell shunt-wound motor made by the Sprague Electric Company. The space which has been reserved in the boiler house for the addition of equipment in duplicate of the present installation at some future date is now being used for the storage of coal.

Our thanks are due to Mr. L. B. Benton and Mr. W. S. Marder for permission to study the power equipment of the foundry and for much valuable assistance in collecting data for this article.

An Iron Foundry Electrically Driven Plant.

THE works of the Reading Car Wheel Company at Reading, Pa., present a more than ordinarily interesting study in the adaptation of electric-motor drive to special foundry processes. It has been said with much truth that the foundry is too frequently considered the fag-end of the plant, and all too often is left to drag along with crude and insufficient appliances manipulated chiefly by main strength and brawny man power. But as a matter of fact, all that can be said concerning the advantages and economy of electrical drive in machine shops, with reference to increased output, decrease in production costs, and general flexibility and convenience, will apply with equal force to the foundry.

The plant at Reading well illustrates this. The works are devoted exclusively to the making of cast-iron wheels, involving very little machine-tool work, and therefore the foundry and its auxiliary departments comprise the main portion of the establishment. The entire plant is operated with electrically-driven appliances, including the blower for the cupola; tipping ladle; hoists and cranes for raising and transporting molten metal, molds and completed wheels; elevator for raising material to the charging room; foundry rattler for cleaning castings; drop test machines, etc.

Not the least interesting feature of the plant is the fact that all the elctrical appliances were installed in 1897 and have been in continuous and satisfactory service since that time, proving beyond peradventure that electric driving is feasible and practicable for general foundry work. Some of the reproductions from photographs accompanying this article show direct-connected motors operating under many months' accumulation of foundry dust and dirt—unavoidable evils in this class of work. These views are valuable as showing what the electric motor can do under trying conditions.

The car wheel plant under discussion is located in the suburbs of Reading, and current is received from the 220-volt, three-wire service of the Metropolitan Electric Company, of that city. From the switchboard at the plant the three-wire system is extended through all the various departments for incandescent lighting, which is used exclusively. For the motors, however, the 220-volt direct-current is taken by two-wire distribution to the various machines, all of the motors being of the single-voltage variable-speed type. For distribution purposes the plant is divided into two sections, either one of which can be supplied with current irrespective of the other. The entire electrical equipment, including all motors, was supplied and installed by the Northern Electrical Manufacturing Company, of Madison, Wis.

FIG. 2.—MOTOR-OPERATED TIPPING LADLE.

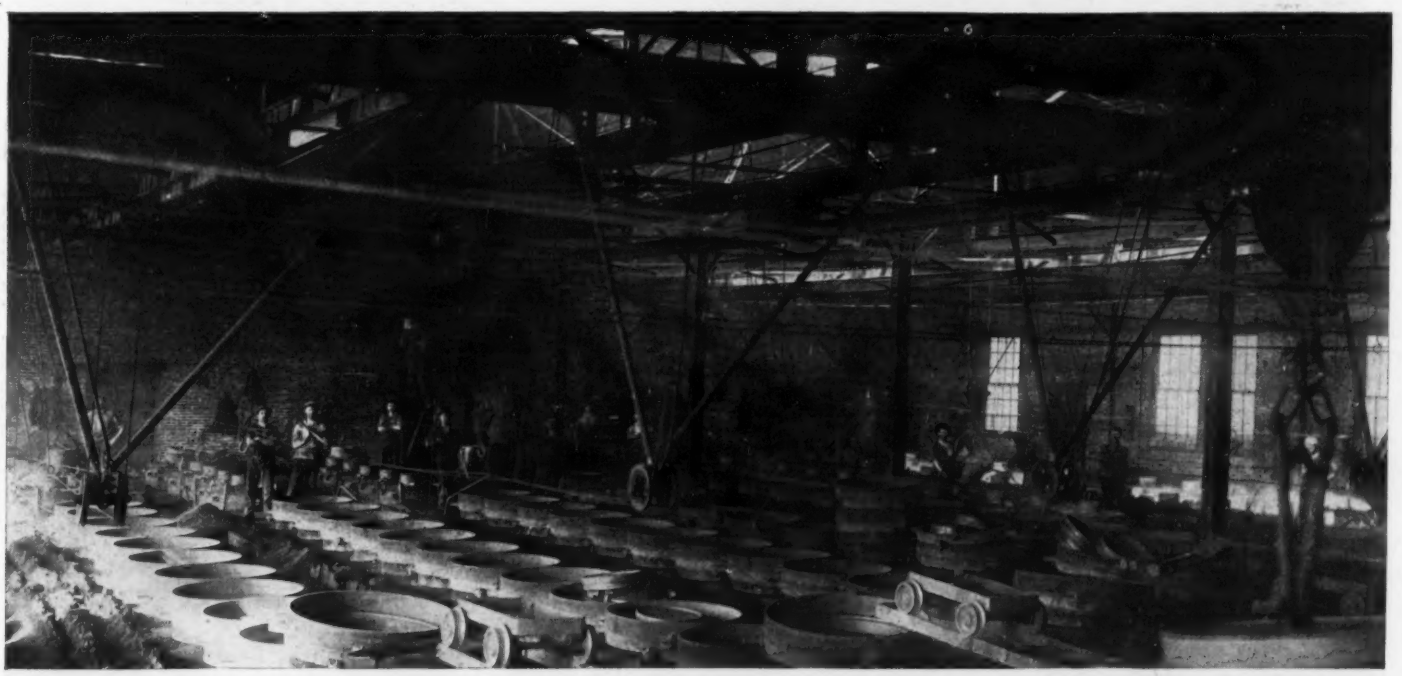


FIG. 1.—GENERAL VIEW OF POURING FLOORS, SHOWING MOTOR-DRIVEN TRAVELING HOISTS AND HAND-CONTROL ROPES.

The largest group of motors is found in the main foundry. These are used for serving the rows or floors where the wheels are cast and also the annealing pits to which the wheels are transferred after the pouring. There are ten of the pouring floors or rows, each row

consisting of 22 wheel moulds giving facilities for making 220 wheels, which is the output capacity of the plant per day. Each row of moulds is served by a separate traveling hoist depending from a small four-wheel trolley running on overhead tracks which extend the full length of each row. Each line of traveling hoists requires one 3-hp motor to operate the hoists and one 1½-hp motor to draw the trolley back and forth. These motors are located in a gallery extending transversely across the pouring floors at one end of the room. An ingenious arrangement of control ropes gives the operators on the floors complete control of the motors for regulating the position of the overhead trolleys and for handling the rise and drop of the hoists. This arrangement is shown in the illustrations. The control ropes pass over guide pulleys suspended from the overhead tracks convenient to the operator's hand from any point on the floor. The control ropes at the motor end pass over small wheels attached to the contact arms on the rheostat boards, so that by pulling the rope one way or the other the resistance is cut in and cut out, as desired.

These lines of traveling hoists serve the triple purpose of carrying the flasks filled with molten metal to the wheel that is to be poured, moving the moulds and patterns, and transporting the red-hot wheel, after the pouring, from the mould to the annealing pit. A similar system of traveling hoists serves the annealing pits, which are arranged in three rows along the ends of the pouring floors.

The ten rows of pouring floors are served from one cupola located on an elevated platform at one end of the foundry. This cupola has a capacity for 65 to 70 tons of metal on a 5-to 6-hour run, or sufficient to pour 220 wheels of standard dimensions. The molten metal flows from the cupola directly into a motor-operated 7-ton tipping ladle, which in turn serves the charge into smaller ladles or flasks, each holding enough metal for pouring one wheel. These smaller ladles are mounted on small four-wheel trucks which can be drawn back or forth in front of the tipping ladle, the trucks running upon a narrow-gauge tramway extending transversely across the foundry floor along the ends of the rows of molds. The movement of the small trucks bearing these flasks is controlled by a 3-hp motor worm-geared to the winding drum.

The operation is therefore as follows: When ready to make a pour, the hot metal is allowed to escape from the cupola into the tipping ladle. By means of a separate 3-hp motor acting through bevelled gears, this ladle is then tipped forward and a charge of metal flows into one of the small ladles or flasks. The truck upon which the flask is carried is then hauled to the end of the row in which the wheel is to be cast. The hoist serving the particular row next takes up the flask and carries it to the mold to be poured, after which the empty flask is returned in the same way. The operation is continuous, the empty flasks being brought to the tipping ladle, filled and delivered to the ends of the pouring rows in rapid succession without interruption. The operation of the 7-ton ladle by electric motor has been especially satisfactory as the operator has complete control of the ladle at each stage of the tipping and can tip the ladle fast or slow, or stop it in any position.

The air blast for blowing the cupola is obtained from a Conners-

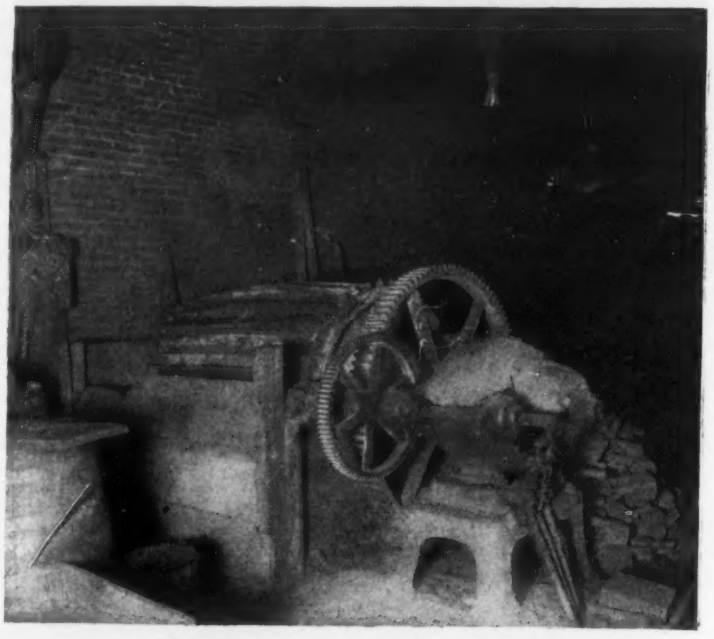


FIG. 4.—MOTOR-DRIVEN FOUNDRY RATTLER.

FIG. 3.—MOTORS AND WINDING DRUMS FOR OPERATING TRAVELING HOISTS.

ville vertical exhaust-fan blower direct-connected to a 35-hp Northern universal motor. This motor-driven blower offers exceptional facilities for regulating, starting and stopping the blast, and the contrast between an equipment operated by belt or small engine and this one, operated by electric drive, is altogether in favor of the latter method.

As will be understood the cupola is charged from the top and this necessitates raising the coke, scrap-iron and pig used in the charging, to the second story. For this purpose an elevator is provided which

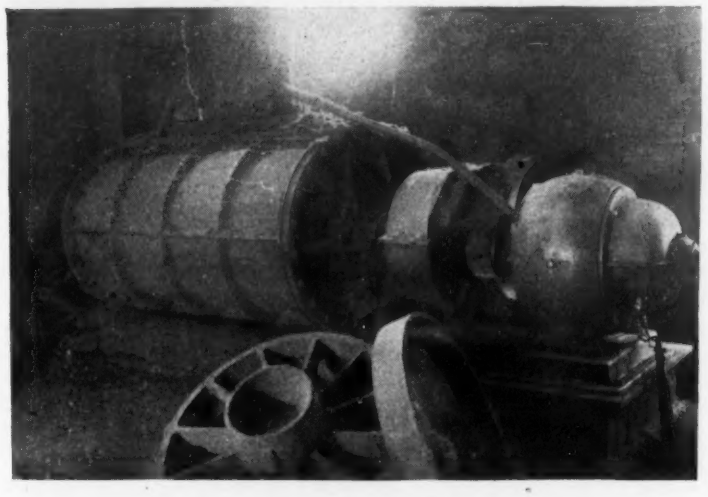


FIG. 5.—DIRECT-CONNECTED BLOWER.

is operated by a 15-hp multipolar motor, belt-connected to the elevator drums. The motor has a rheostat controller working in conjunction with a solenoid self-starting control, with oil dash-pot for equalizing the movement of arm cutting out resistance.

The wheels produced at this plant are subjected to the standard drop-test. That is, two wheels from every hundred are placed under a falling weight and are struck 12 blows with a 140-pound weight falling 12 ft. For lifting this weight during these tests there is a 1½-hp constant-speed dust-proof motor. While making a test the

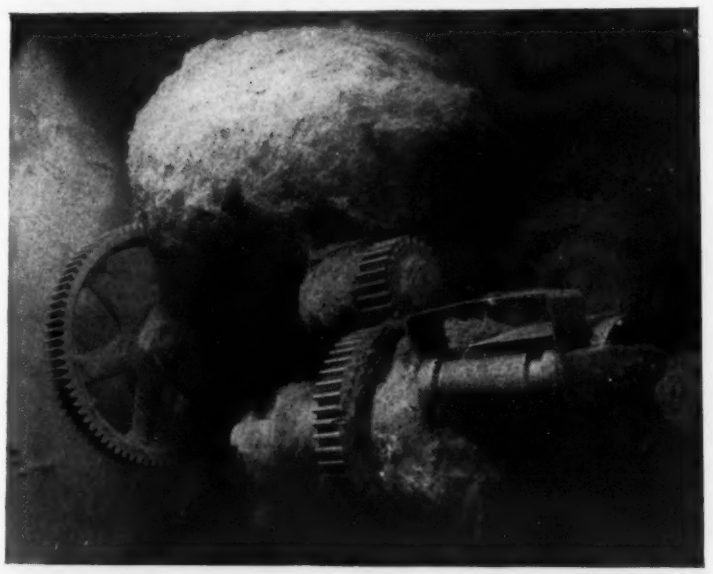


FIG. 6.—MOTOR OPERATING UNDER ACCUMULATION OF FOUNDRY DIRT.

motor runs continuously, and the weight is cut off automatically and allowed to drop as soon as it reaches the maximum height.

A somewhat similar apparatus is used for breaking old wheels that are returned from the users as scrap. Two wheels at a time are placed over a pit and are struck one blow by a 15,000-pound weight dropping 35 ft. This weight is raised by a 5-hp motor. As in the case of the other appliances described, the application of electric motors to lifting these weights has resulted in greater flexibility and convenience of manipulation and has introduced appreciable economies.

The foundry is equipped with an electrically-driven tumbling machine, or rattler, for cleaning small castings and scrap. The machine is direct-connected to a 10-hp back-geared dust-proof motor.

It is occasionally necessary to bore out the center of completed wheels, and for this purpose there is provided a Niles boring mill which is driven by a 7½-hp multipolar motor. Adjacent to the foundry is a small machine shop which includes an emery wheel, lathe, blacksmith forge, drill press and circular saw. These are all belted to a common shaft, which is rotated by means of a 1½-hp motor.

The electrical equipment at this plant, as described, includes 35 separate motors. All of these are of standard designs built by the Northern Electrical Manufacturing Company, and it is to the credit of the motors that they have been in continuous and uninterrupted service for seven years under conditions of dirt and dust that would seemingly render satisfactory running a very difficult matter. It is to be regretted that production costs in detail at this plant are not available, but the statement is made by the management of the car wheel company that the output of the plant has been increased nearly 100 per cent. per day by the electrical equipment over previous methods of driving.

Electric Power in Factories.

BY A. W. HENSHAW.

THE use of electric light in mills and factories is now so common that one seldom sees a factory of any importance without such an equipment. Electric power, however, for driving machinery while much less commonly used in such places at present, has had a most remarkable growth in its application during the last few years, and the matter has aroused such widespread interest that nearly all progressive manufacturing concerns are questioning more or less seriously whether they should not adopt the system for their own plants. It is the purpose of this article, first, to point out the reasons for such great popularity, and then to give some general information which will be found helpful in determining the particular system of application or type of machinery which is best adapted to any given condition in factory equipments.

Among the many advantages which the electric system has over the mechanical system for the distribution of power in factories, the first one which is brought to mind is the ability to transmit power to such great distances in comparison, and to almost any locality regardless of the location of the prime-mover. This is most frequently seen in cases where the water power is available at some distance from the factory, either because it has been found available after the factory has been built or because it has been impossible to locate the factory near enough to the water power to transmit mechanically.

Frequently it is even cheaper to generate the power a long distance from the factory when coal is used, if the expense of getting the fuel to the factory is considerable, as in the case of metal mines, reduction works, etc., located at some distance from the railroad. This almost absolute independence of the factory, so far as the location of the power plant is concerned, makes it possible to generate the electric power low down on the banks of a stream and to locate the factory up considerably higher where better light and air are available, and where the connections with the railroad are much more feasible. Further than this, the individual machines in the factory are not tied down to any definite location on account of their relation to the shafting, but can be placed wherever convenient with a considerable saving in operating expenses. Then, when it comes to the point of enlarging the factory and adding more machinery, this can be done in any direction regardless of the source of power.

The saving in waste power due to friction of belts, bearings, gearings, etc., is frequently a very important item. The amount of power used up in friction in various mills differs very widely, and it is difficult to even estimate beforehand what this is likely to be. If this power is measured by taking indicator cards on a steam engine, which drives a mill mechanically, and is assumed to be equal to that delivered when the engine is driving only the shafting and belting, this friction loss will generally vary between the limits of about 20 to 60 per cent. of the total power which the engine denotes. This, however, measures merely the power required to drive the shafting and belting without any load, and if there were any way by which we could measure this friction when the belts are under full tension and the bearings subjected to their maximum pressure under

load, we should probably find that the total friction loss would be at least 50 per cent. greater than that which is measured at no load. Of course, the losses under a system of electric drive are also different under different circumstances and usually include a certain amount of belting which it is advisable to have in conjunction with electric motors.

For an average case, however, in order to make a comparison, it seems safe to say that the friction loss under full load in shafts and belts will be at least 50 to 60 per cent. of the total output where the mechanical system is used, and with the electrical system an average figure would be about 25 per cent. loss in the electrical machinery, including everything from the engine to the motor pulleys, and about 15 per cent. loss in such belts as would be required. Of course, where everything is in the best condition, where the mechanical system is used, the friction losses will be less than the average, and under these circumstances it is customary to assume that in the average mill the efficiency of the electric and mechanical systems under a full and constant load are practically the same. It should be noted, however, that the losses in the electrical machinery are constant for a given load, while the friction losses in long lines of shafting are continually varying, due to the fact that it is absolutely impossible to keep the bearings in good condition and strictly in line without mounting them on solid masonry foundations. For these reasons there probably are a very few, if any, plants operating with the mechanical system of transmission where the efficiency is as good as might be obtained with the electric system, and in the average plant the efficiency of the mechanical system under actual working conditions is quite a little poorer.

Electrical machinery as it is manufactured to-day is of such a simple type that the depreciation, the cost of maintenance and repairs, and the expense and delays due to shut-downs are considerably less than where the mechanical system of transmission is used. It has been commonly supposed that on account of the fact that the intricacies of electrical designs are understood by only those directly concerned with them, it is necessary to have a number of especially trained experts to look after such machines; but in actual practice less supervision is required over the electrical machines than to keep shafts and belts in good condition, and usually there is considerable saving in the cost of replacing worn-out parts.

Where the power for driving a factory is transmitted mechanically, it is necessary to use a single engine or water wheel connected to a complete system of shafting and belting running as one unit complete, unless various sections are subdivided by the use of friction clutches or similar devices. A friction clutch, while entirely practical, has a great many disadvantages and frequently causes serious troubles, and any type of jaw clutch is open to the serious objection that it cannot be coupled in without shutting down the machinery. Where the electric drive is used, however, the ease with which individual generators or motors may be thrown into circuit is ideal. For this reason, it is customary to use at least as many as two separate prime-movers with their generators, making it possible to run at least a large portion of the factory in case one of the units is shut down for repairs. Where a factory is run night and day this obviously enables us to keep the engines in very much better condition by shutting down one at a time for necessary adjustment of parts. Such an arrangement, also, is of great value in some classes of work where a portion of the factory must run at times, while the remainder is shut down, such as during night hours, it being possible to run the engines and generators at approximately their normal load continuously by adjusting the number which shall be kept running to the total amount of power required. The expense of running engines at small loads is seldom fully appreciated.

In the same way, not only is there considerable saving by this flexibility in the generators and prime-movers, but the freedom with which any motor driving a single machine or a group of machines may be shut down and started up is of the greatest value in cases where machinery is used only a part of the time, or where any changes are being made in the factory, or repairs are being carried on. If a single department in a large mill is required to operate overtime, only the motors for this department need be run and the rest may remain idle with considerable saving in expense.

In nearly all classes of work there is some advantage, and in some classes a very great advantage in the omission of all or nearly all the belts and shaft hangers which are commonly used. In silk mills, paper mills, confectionery factories or laundries, for example, it is of the greatest importance that the goods which are being manufactured are kept perfectly clean, and so long as there are shaft hangers or belts overhead it is absolutely impossible to avoid a certain amount of dirt and injury to the goods. The almost perfect cleanliness of an establishment where the electric drive is carefully worked out is something which needs to be seen in order fully to be appreciated. Moreover, the absence of dirt in the air is bound to be more healthful to the employees, and the amount of light available, and consequently the quality of the work wherever belts are omitted, is very greatly increased. The omission of belts also reduces the amount of noise and takes away the element or risk of injury to the operatives. Contrary to the common impression among many people, the possibility of injury or even of a slight shock from the electric current is reduced to practically nothing by the methods of constructing machines and installing wiring, which are now commonly employed as enforced by the insurance companies.

The omission of long lines of heavy shafting not only saves considerable expense due to their installation and maintenance, but in a new factory makes possible a material saving due to the fact that a very much lighter construction in the framework of the building is possible.

In the types of electric motors which are commonly used there is a small "slip," so called, between the speed of the motor at no load and that which it gives at full load. This slip, however, is never so great as is experienced with the best belting, and there is a further advantage that the slip in an electric motor never varies, but is always the same for the same load which it delivers. In the case of belts, however, as soon as they become a little worn, or lose the proper amount of flexibility, the question of slippage is apt to become quite serious. In some classes of work this is of small importance, but for other classes it is vital, as, for example, in all kinds of textile work where a change in the quality of the goods is noticeable upon the slightest change in speed. It is the universal experience among factory managers who have installed the electric drive that they are able to obtain a speed regulation which is an immense improvement over that which they have ever experienced with the machanical system.

Where power is distributed throughout a factory mechanically, it is possible to obtain only a very rough estimate as to the amount of power which each machine or group of machines is using. One great advantage of the electric system is that the power developed by any motor can be measured with the greatest ease. It is customary in installing electric motors to run each circuit which supplies current to a motor, or a group of motors, through a distributing panel on which is mounted the necessary ammeter or wattmeter, which will show the amount of power which is to be supplied to the motor; then, by subtracting the small losses in the motor, which can be very accurately determined beforehand, we can tell exactly how much power each motor, or group of motors, is delivering at any time.

The knowledge obtained by the use of a voltmeter and ammeter, or a recording wattmeter, makes it possible for a factory manager to keep very close watch of his work, and to note very easily the change in the amount of power required where any change is made in his machinery or his methods. In this way, many a factory has been able to introduce economies in power which have resulted in very material saving. Moreover, if anything goes wrong with the machinery it usually begins by taking a little more than the normal amount of power, and this is quickly detected by means of the instrument and sometimes considerable damage is prevented by the knowledge of the state of affairs before the trouble has gone too far.

If electric power is used the current is available for lighting, either arc or incandescent, and it is, therefore, unnecessary to run a separate lighting equipment. The same current is also available for hoists and cranes.

To one not thoroughly familiar with the use of electric machinery for power distribution in factories, such a large number of advantages as compared with the mechanical system seems almost impossible, but the proof of their truth is in the earnestness and enthusiasm with which any factory superintendent or manager who has used the electric drive will declare that he would not under any circumstances get along without it. If a company has once adopted the electric system it is sure to adhere to it always. Few entirely new factories of any importance are planned in these days for mechanical drive, and more than this, in accordance with the American spirit in manufacturing, many companies are now actually disposing of machinery in good condition which has been

installed for the mechanical system and are putting in the electric drive.

In order to obtain even an approximate estimate as to the cost of the electrical equipment of a factory, there are a number of points which should first be determined. Naturally, we begin with the question as to the amount of power required and the sizes of the motors. This brings up the question as to how far the units should be subdivided. In some exceptional cases a single motor is installed to operate the entire factory, this being, of course, more feasible in small factories than in large ones. Sometimes, also, the other extreme is adopted and the individual drive is used, a single motor being connected to each machine in the factory. This latter arrangement is seldom used all over the factory, but there is frequently one department where for some special reason it is desirable in order to get rid of the belting. Of course, where variable speed is required, as in the case of certain machine tools, printing presses, etc., and where the changes in speed are to be obtained solely by control of the motor, it is necessary to use the individual drive. Also, if any machines in the factory are so large as to make it economical, it is best to use a single motor for each machine. This is the case, for example, in driving tube mills in the manufacturing of cement. Where a number of machines are grouped together on one motor, as is usually the case, the best arrangement depends upon individual circumstances. The machines should be so selected that in the ordinary course of work they will generally be shut down together, and if the power which they require is variable they should be so grouped as to make the average power required for the motor as near as possible to the maximum.

The question as to the amount of power required to drive any single machine or small group of machines, is often difficult to determine. In a factory which has been running under the mechanical system, the superintendent has a pretty good idea as to the total amount of power required, but it is impossible for him to judge accurately as to the power taken by each machine. The manufacturers of various kinds of machinery are always willing to state the amount of power, but, on account of competition, their tendency naturally is nearly always to underestimate rather than overestimate, and the data which they furnish are seldom very accurate. They are further hampered by the fact that in many cases their measurements of power are made by dynamometers or some mechanical arrangement. There is, of course, no method of measuring power equal in accuracy to that in which an electric motor is used, and the various electrical manufacturing companies as well as many consulting engineers have taken advantage of this fact and in some cases have gathered a large amount of information so that they are probably in a better position to recommend the size of motor required than anyone else.

Of the various methods of connecting a motor to the machine or shaft which it is to drive, those most commonly in use are direct-connection, gearing, belting or the chain drive. Of course, where the speed of the machine is adapted to a reasonable speed for the motor, direct connection is generally the best arrangement. This system is sometimes used even where motors drive line shafting from which small machines are belted, provided it is possible to run the shafting at a high enough speed to use a motor, the cost of which is not excessive.

Gearing of some sort is generally used where the speed reduction from the motor to the driven machine is very large, and, of course, has the advantage of saving considerable space as compared with belting, but it has the disadvantage for some classes of work that there is no flexibility between the machine and the motor, so that any shock in the machine is transmitted to the motor. Belting from the motor to its machine or a line shaft is the most common method used.

The use of chain drive has become more common recently by reason of the fact that it is now possible to obtain chains which are so designed that they are practically noiseless in operation and are subject to very little wear. Their efficiency is very high and for some classes of work they are admirably adapted. They have the advantage over belts of saving considerable space, since very short distances between centers can be used, and they also make it possible to use a very much greater ratio between the speeds of the motor and the machine than can be used with belts. These chains cannot be used at a very high speed, however, and of course are not so flexible as belts.

In deciding the method of drive for the motors the question often comes up as to where the motor can be located. Electric motors as they are designed to-day are always arranged so that they may be located either on the floor or, if desirable, on the side wall or on the ceiling, arrangements being made so that the bearings will hold the oil properly when the motor is turned into any of these various positions. Where possible it is generally better to place the motor up high on the wall or the ceiling, where it will be out of the way, although if direct-current motors are used such an arrangement is somewhat questionable, on account of the fact that the operation of the commutator cannot be watched so easily.

The question as to whether a factory should generate its own power, or should purchase from some electric power company must sometimes be decided, and usually the item of expense determines the matter. In general, however, other things being equal, it should be an advantage for the factory to purchase power outside, and if the electric power company furnishes lights it will be pleased to accept a steady day load. It is true that the price will include a profit for the company, but generally, unless the factory is quite a large one, the electric company should be able to generate its own power more cheaply. If power is purchased from an electric light and power company there is this advantage, that it is possible to use lights or a small amount of power for night use without the expense which would ordinarily be entailed by running a generator considerably larger than is necessary. Of course, if the factory requires a large quantity of steam for use in connection with its work, as in the case of woolen mills, paper mills, etc., it will in most cases be more economical for each to generate its own power.

If electric power is purchased from outside there is seldom any opportunity to choose whether it shall be alternating or direct current. If the factory generates its own electric power, however, this question becomes quite an important one. In general, the alternating-current, polyphase induction motor is much to be preferred to the direct-current motor. The former has no commutator or brushes or moving contacts, and on the winding of the rotating part has a very much lower potential. It is such a simple type of motor in comparison with the direct-current motor that the expense for maintenance and repairs and the possibility of delay due to troubles is practically negligible.

It is also possible to install the induction motor in out-of-the-way places where it cannot easily be inspected, whereas with the direct-current motor its operation ought to be watched more or less closely. The induction motor can run in very dirty surroundings without injury and requires less expensive attendance. Its speed changes very much less under variations in load and it will carry much larger overloads for short periods of time without injury. In cases where a variable-speed motor is required, which must run at high efficiency when the speeds are low and must hold a definite speed regardless of its load, the direct-current motor is more suitable. This is the condition of affairs in machine tool driving where the individual tool is operated by a single motor and the speed variation is to be obtained electrically.

Where the electric power is generated at some distance from the factory, say a half mile or over, it becomes necessary to use alternating currents for transmission, in order to make use of a higher voltage than can be adapted for direct current, and such conditions would frequently decide a doubtful question, but of course under these conditions if direct current is absolutely necessary for operating a portion of a factory, it can be obtained by the use of a rotary converter or a motor-generator set which will transform from alternating to direct current.

Some of the above statements in regard to the comparison between direct-current and alternating-current motors apply to synchronous motors, which sometimes are preferred rather than induction motors. The advantage in the synchronous motor is in the fact that it is possible to operate it at practically 100 per cent. power factor, thus reducing the current required by about 10 per cent.; the disadvantage is in its very small starting torque, and the fact that it is a somewhat more complicated machine than an induction motor. In some cases where very large motors are required of capacities above perhaps 150 or 200 hp, it is advantageous to use synchronous rather than induction motors, and in such cases direct-current motors probably would never be considered.

If the alternating-current system is used it is necessary to decide what frequency shall be adopted. In the United States 60 cycles is almost universally the standard frequency, so that if there is no special reason for any other frequency this would probably be used

in nearly every case. It has the advantage that since it is so commonly used very prompt shipments of apparatus can generally be obtained, and the motors and transformers are slightly cheaper. Where very slow-speed motors are required, however, a lower frequency may be preferable. This lower frequency would generally be 25 cycles if common American practice is followed. Any frequency lower than 60 cycles, however, has the disadvantage that arc lamps cannot be used satisfactorily, and for frequencies as low as 25 cycles incandescent lighting is only made satisfactory by the use of lamps having a low efficiency.

In polyphase, alternating-current systems there is the choice between two-phase and three-phase systems. Where the power is to be transmitted for any great distance or where the wiring in a mill is any considerable proportion of the expense, it is invariably better to use a three-phase rather than a two-phase system, since under the same conditions 25 per cent. less copper for the conductors is required, and the expense of running three wires instead of four is less even for the same total amount of copper. Where any considerable proportion of the load is to be used for lighting, the two-phase system has some advantage, however, in that it is somewhat simpler to balance the single-phase lighting circuits among two rather than three phases, and the voltage of each circuit can be more easily regulated independently.

The question as to whether a single-phase system should be adopted is seldom raised, so far as the complete electric equipment is concerned, since either two-phase or three-phase machines are cheaper, and in the case of the motors very much simpler. Where very small motors are required, however, it is in some cases preferable to use single-phase motors, even though the power generated is two-phase or three-phase, on account of the fact that the expense of running two wires instead of three or four and of using one transformer instead of two or three may be somewhat less.

Another somewhat important consideration is the question as to what voltage should be used. If the power station is some distance from the mill, say a mile or more, the problem becomes one of transmission rather than distribution. A high enough voltage must be used in order to reduce the cost of the transmission line to as low a figure as possible. Naturally, it is best to use a voltage which has been standardized by the various electrical manufacturers, such as 2,200, 4,400, 6,600, etc., rather than try to adopt a special voltage. In round numbers, it may be said that it is good practice to allow about 1,000 volts per mile of distance between the power house and the center of distribution.

In most cases where electric power is to be applied to a factory, the distance from the generator to the farthest motor is not more than a few hundred feet, and most of the wiring is interior rather than exterior work, so that the problem is one of distribution rather than transmission. If direct current is used the limit of the voltage is, of course, 500 or 550. If alternating current is used this same limit is seldom exceeded, although sometimes where it is made necessary by the distance of the power station the standard voltage of 2,000 or approximately that figure is used for the motors. In such cases, however, transformers would be required where small motors are used, since it is possible to build only the larger ones for such a high voltage. Further than this, the 2,000-volt motors are more expensive and the requirements of the insurance underwriters are more severe, making the expense of the wiring generally greater.

On the various lower voltages for distribution, those which are most generally considered standard are approximately 125, 250 or 500 for direct currents and 110, 220, 440 or 550 for alternating currents. Although the final determination of the voltage to be used generally requires a careful investigation, we may say for preliminary purposes, that it is not generally necessary to go to a higher voltage than the average distance in feet from the generator to the motor, the distance, of course, being measured along the path which will be taken by the wiring. In large factories 440 or 550 volts is the potential most commonly employed, and in smaller factories 220 volts. Occasionally, in very small plants, 110-volt motors are used. The problem is sometimes affected to a certain extent by the amount of power to be used for lights. It is not generally considered advisable to use higher than approximately 110 volts in incandescent lamps, on account of the fact that the expense would be greater and the lamps would have either a lower efficiency or a shorter life. Sometimes, in order to use 110-volt lamps, with higher voltage for the motors, alternating-current generators are arranged so that by bringing out a tap at the middle point of each phase of the two-phase winding, or a tap from the neutral of the star-connected, three-phase winding, the lower voltage can be obtained for the lamps and approximately 200 or 220 volts for the motors. In direct-current systems a small balancer set is sometimes used so as to obtain one-half of the motor voltage for the lamps. Where 440 or 550 volts are used for the motors, it is necessary to have some device like a motor-generator set for direct currents or a transformer for alternating currents to obtain approximately 110 volts for the lamps.

If direct-current motors are used there is very little choice between various types. Shunt-wound motors are almost always employed, although occasionally it is preferable to have them compound-wound. Where variable-speed motors are necessary with a large starting torque and capable of running at very slow speeds under heavy loads, the series motor is used, as is the case in hoists and cranes.

Where alternating-current motors are used, which would in most cases be induction motors, there are commonly three types offered by American manufacturers. The motor having a squirrel-cage armature is generally advisable if conditions permit, since it is the simplest of all motors and its revolving part is scarcely more complicated than a solid piece of iron. Where a motor must start a heavy load, however, and is large in proportion to the size of the generator, the motor with squirrel-cage armature may be objectionable on account of the large starting current required, under which circumstances a motor with starting resistance inside of the armature is best. A third type of induction motor commonly in use has collector rings on its armature and the necessary starting resistance is external to the motor. This type of motor is generally used only in those cases where the requirements of starting or regulating the speed are such that a larger starting resistance or controller is required than could be placed inside of the armature. This is illustrated by the use of the collector ring on motor for hoists and cranes.

Before completing the list of motors to be used in a factory, it will be necessary to determine the speed required. For gearing, and also in many cases for chain drive, a slower speed is better than that which is standard for belt drive, in order to avoid the very objectionable noise and wear of the gears. For belting it is usually possible to employ the speeds standardized by the various manufacturers for this purpose, and unless the motor is special it is generally found that the higher the speed the cheaper is the motor. It should be remembered, however, that it is generally better to avoid any higher ratio between the speed of the motor and the speed of the machine which it drives, than about 4 to 1, and it is sometimes desirable in order to avoid too high ratios to employ a rather more expensive motor operating at slower speed.

Where electric power is to be generated by the factory it will be necessary to determine the number and sizes of generators to be used. If every motor in the factory were always operating and at its normal load, the output of the power station would be found to be approximately equal in kilowatts to the total output of the motors in horse-power; but since some of the motors are always sure to be operating at partial loads, or may even be shut down, we must multiply the horse-power rating of the motors by a certain load factor in order to determine the average output required from the generators, and this load factor can easily be determined approximately in each individual case.

As to the number of generators, there should nearly always be more than one if possible, so that in case anything should go wrong, either with the engine or water wheel, or with the generator, at least a considerable proportion of the factory could be kept in operation while repairs are being made. In the average factory it is considered good practice to install about two generators, each equal to at least one-half of the total average load. It is better, as a rule, not to use one large and one small generator as is sometimes advocated, since there is considerable advantage in having the two generators and their engines or water wheels duplicates of each other if possible. In large factories, more than two generators, of course, are preferable, and in this way an accident to one means the disabling of a much smaller percentage of the factory. Of course, in all these estimates as to the sizes both of generators and motors, it is well to remember that for an hour or two at a time electrical machinery will stand a considerable overload without reaching injurious temperatures.

The speeds of the generators, if they are direct-connected to water wheels, will generally be determined largely by the head of water available. If they are driven by steam engines the speed will, of course, depend upon whether they are belted or direct-connected. The former arrangement is to be recommended only in the smaller sizes, since the saving in cost of maintenance, waste power and

space in the power station makes it very much better, if possible, to avoid the use of belts. For the generators direct-connected to engines, a higher rather than a lower speed is generally cheaper, and, if a good type of engine is used, should be just as satisfactory.

The requirements for a switchboard to control the electrical equipment of a factory have now become pretty well standardized. If electric power is purchased from outside, a receiving panel is generally required, both for the high-potential and the low-potential side of the transformers, if they are used, containing the necessary switches, voltmeter, ammeter or wattmeter. An automatic switch or a set of fuses is necessary to protect from heavy overloads or short-circuits, and if the transmission line is run out of doors and overhead some form of lightning arrester is necessary. If the power is generated at the factory, it is customary to install a panel for each generator, including the necessary ammeter for the field circuit, and ammeters or wattmeters, or both for the armature circuit, together with a voltmeter. If more than one generator is used, it is best to arrange so that they may be operated in parallel and the necessary synchronizing indicators should be supplied if alternating currents are employed. In all cases it is advisable to have some form of distributing panels, unusually in the dynamo or transformer room, to control the circuits running to the motor. These should be equipped with switches and with automatic circuit-breakers or fuses, and also with ammeters or wattmeters for showing the amount of power delivered to each circuit. If motors are direct-current, ammeters are used on these panels. For alternating-current motors it is customary to use wattmeters which will measure only the energy current and not the wattless current, so as to give an accurate indication of the amount of power used. As a rule, these wattmeters are of the indicating type, so that the power being taken can be read at any instant. It is of great value to have recording wattmeters in addition to the indicating wattmeters, so that it may be possible to read the average amount of power which has been used during any period of time. A complete and carefully designed switchboard will always be found a good investment if a reasonable amount of attention is given to keeping close watch of the power used, and careful reports based upon the readings of the instruments will be of great assistance to factory managers.

In all that can be said in regard to the application of electrical machinery to the distribution of power in factories, only the most general statements must necessarily, of course, be employed and the actual requirements will vary very widely under different circumstances. The details must, of course, be worked out for each individual case by itself. It is believed, however, that the knowledge of the various points brought out above, which are not at all theoretical, but are based upon actual and sucessful practice, will enable any factory manager to form a good general idea of what his requirements are, and to ask intelligently for approximate figures from the electrical manufacturers in order to make his first preliminary estimate. After this the problem in each case must, of course, be worked out by a consulting engineer, or by the experts employed by the various electrical manufacturing concerns, who, through their wide experience, are generally able to solve most satisfactorily the problems involved.

Electric Motors in Ore Handling.

The advantages of the electric motor in ore handling at docks are clearly brought out in an article by Mr. H. E. Scott in the *Journal* of the Worcester Polytechnic Institute, describing the ore-handling plant at Conneaut, Ohio. About a year ago four electrical unloaders were erected at Dock 4, and began operation last June. The purpose of these machines was to increase the economy, rather than the speed, by further reducing the hand-labor.

The speed attained by a hydraulic machine, handling a bucket of about ten tons capacity, has never been equaled. The electrical machine handles a five-ton bucket, and without hand labor in the hold of the boat maintains an average speed of 150 tons an hour until 75 per cent. of the cargo has been unloaded. This is done with about one-third the operating labor used on a hydraulic machine. The number of men employed on the four electrical machines is seven; there being one foreman, four oprators and two oilers for the plant. By way of comparison, the four hydraulic machines require one foreman, four operators, four pump-tenders, four operators for transfer car and moving gear, four firemen, one ash man, one cable man and one messenger. During the cleaning up the electrical machine requires five men in the hold of the boat; while for the same purpose the hydraulic machine has eight men.

The Application of Electricity to a Large Manufacturing Industry.

THE extent to which electricity is now influencing modern manufacturing methods is well illustrated in the new manufacturing plant of the Ingersoll-Sergeant Drill Company, which is typical of all that is modern and up-to-date in the machine building industries. The plant is located in the outskirts of the city of Phillipsburg, which is directly across the river from Easton, Pa., where

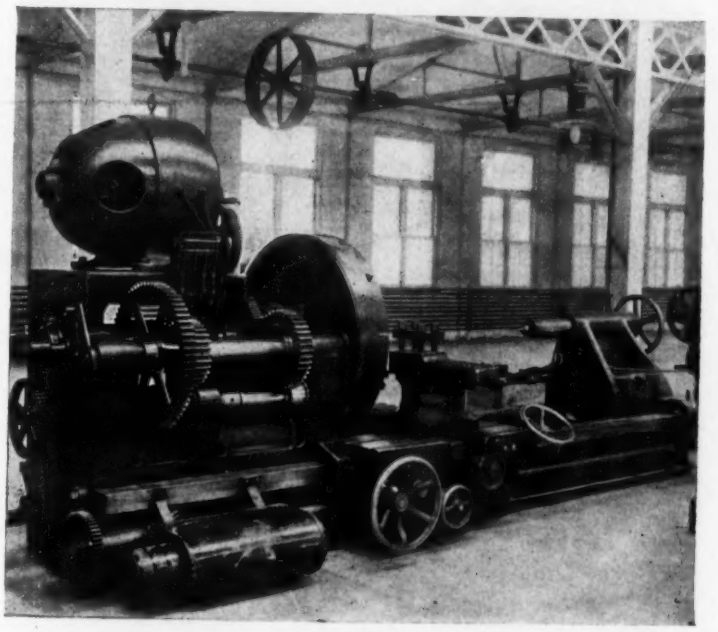


FIG. I.—APPLICATION OF MOTOR DRIVE TO A HEAVY LATHE.

the former works of the company are located. A plot of ground of nearly 200 acres in area was secured upon high and well-drained land, which is most favorable to the manufacturing plant's requirements. Here valuable railroad connections were easily secured with both the Delaware, Lackawanna & Western and the Central Railroad of New Jersey, while an abundant water supply is available not only from a deep well, but from a dam which was secured some four miles distant and at an altitude such as to maintain a constant water

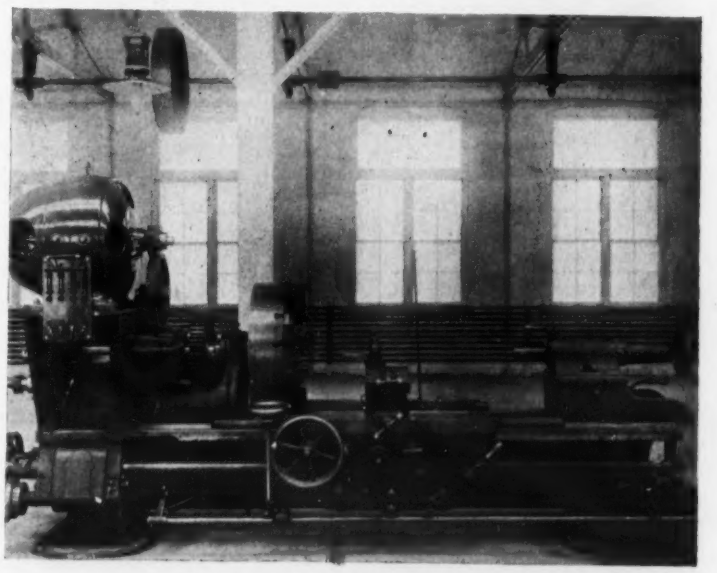


FIG. 2.—A MOTOR DRIVE UPON AN ENGINE LATHE.

pressure of over 100 pounds. This site, having ample provisions for the maximum possible extensions of buildings, thus enabled a building arrangement to be made which should be most favorable to the requirements of the different departments. While the power plant is located practically in the center of the site, still the buildings have been located in such relation to the power center as to favor not only their future growth, but also the interchange of materials which would be necessary between the stock and shipping rooms and the

various departments. It is estimated that the latter consideration will prove one of the most economical features of the entire installation, and it is to be noted that this result is due directly to the use of the electrical system of power distribuion.

The application of electric motors for the direct driving of machine tools for the manufacturing processes is perhaps the most interesting and valuable feature of this installation. It has come to be known in the recent development of motor driving systems that the use of the individual drive by which variable speeds may be easily and instantaneously supplied to the machine driven, is a source of great economy, particularly upon machine tools in which various grades of metals are encountered and various diameters must be machined. These require for the best results frequent and wide changes in the speed of the machine, which are, as is well known, obtained with difficulty in the older types of machine tool drives using cone pulleys and belts. By the use of the variable-speed electric motor with suitably located controller, in accordance with modern practice in this line, the tool operator has available at the spindle of the machine a large number of speeds, increasing by convenient increments, which are best adapted to the requirements of that particular machine. In this way it is not only possible, but it is convenient to frequently change the speed of the tool in order to bring up the productive capacity to the maximum that is possible with the conditions operated under.

In the operation of the machine tools with the cone, belt and pulley method of driving an adverse condition in human nature is encountered in that the operator is unwilling to change the speed of the machine oftener than is absolutely necessary for the reason that such a change involves considerably more trouble than he is usually willing to give it. In other words, frequent changes of speed with the cone pulley method of driving are so inconvenient as to make them impracticable, whereas if the direct motor drive with controller method of changing speed be used, speed changes are so easily obtained as to be made without taking the attention

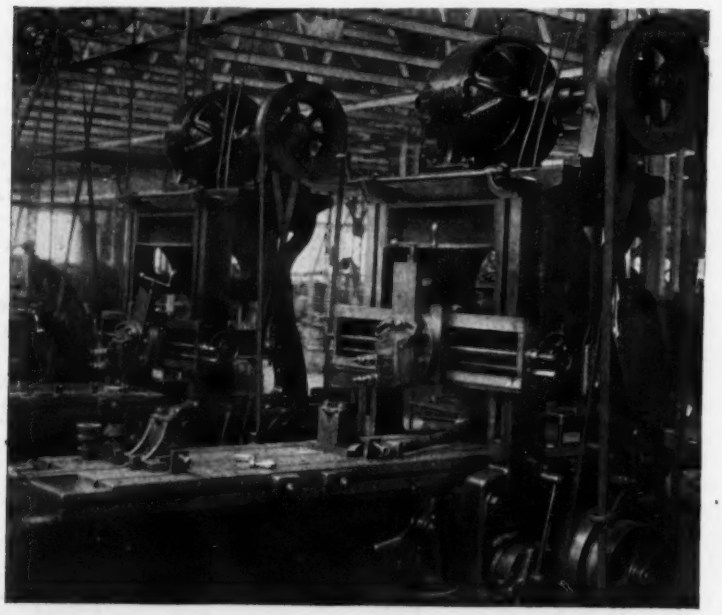


FIG. 3.—FLY-WHEEL DRIVES FOR PLANERS.

of the operator from his work. Herein lies the great operative economy of the individual variable-speed drive. By mounting the controller handle upon the carriage of the lathe, so that the entire operation of the motor may be controlled from that point and without trouble and delay that would otherwise be necessary, increases of production for a given tool of from 300 to 400 per cent. have in numbers of cases been secured, and this with no other change of conditions of operation.

The Ingersoll-Sergeant Company decided to take advantage of the possibilities that were open to them in this direction and have studied the driving problems in their machine shop with great care. A number of accompanying illustrations will illustrate the methods of application that have been worked out with this result in view, and a careful review of their details will be interesting.

All tools which are of sufficient size to require a large power consumption for their operation and are to operate upon varying diameters and different classes of material, have in general been equipped with individual variable-speed drives. The latest tendencies in lathe driving may, for instance, be noted in Figs. 1 and 2 in the mounting of the motor upon a special bracket above the headstock with gear connections to the driving spindle. Such arrangements were made in a large number of different cases of tools. In the case of the planer the preferable arrangement has been to mount the motor above the housing upon specially designed brackets as illustrated in Fig. 3: in this connection is to be noted the use of very heavy

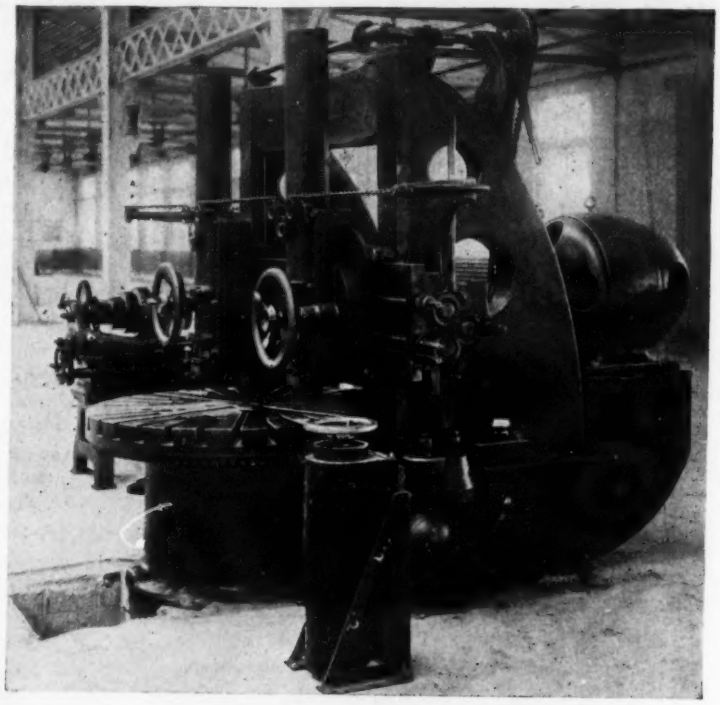


FIG. 4.—THE MOTOR DRIVE UPON A LARGE BORING MILL.

fly-wheels for overcoming and taking up the extreme thrust that is imposed upon the motor at reversals of the motion of the platen, this being the most approved practice in methods of planer driving. Also a boring mill drive is illustrated in Fig. 4, in which the motor is supported upon a bracket bolted to the rear of the housing. These examples will indicate the recent tendencies in methods of mounting the motors upon standard types of machine tools, in which connection it is to be noted that the most up-to-date machine tool builders are in nearly all cases at the present building their tools so as to be readily equipped with motor brackets for this purpose. In the case of lathes it is usual to remove the upper bearing caps of the headstock spindle and mount in their place a horizontal bracket which combines in it the top spindle bearings and a strong and rigid motor supporting bracket. Similar details are being worked out for all other types of machine tools, as may be noted herein.

In the cases of the two lathes illustrated herewith in Figs. 1 and 2, it will be noted that in each case the drive to the headstock is through gearing reductions to an intermediate shaft and from the latter to the spindle through either one of three gear changes as desired, the latter being capable of easy change. In this way an individual drive with a motor having a three to one speed range, and a suitable arrangement of change gears, will increase the effective speed range of the motor some three or four times and give the tool from 60 to 80 speeds, which will easily cover any possible class of work to which it may be subjected. The style of change gear mechanism that is to be supplied is that which has been recommended by the Crocker-Wheeler Company, who have furnished the generating apparatus and motors for this installation. This mechanism provides a system of levers by which either three or four-gear trains may be thrown in, and yet so interlocked that two of them cannot be thrown in together and damage the gearing.

The arrangement of controllers for the lathes, which is of vital importance to the success of the method of driving, is interesting and novel. In each case the controller is mounted upon the bed close to the floor with a splined shaft either connected directly to the controller or to it through gearing. A bracket on the carriage supporting the controller hand wheel carries also the splined shaft which it turns through a sliding sleeve which keys with it, so that

the controller is readily handled from the horizontal hand wheel, which is at all times convenient to the operator of the tool. This arrangement places the control of the motor directly in his hands and makes the various adjustments of speed, either large or small, most easily accomplished. For instance, in the case of facing a large

FIG. 5.—OUTLET SCHEME FOR CONNECTING MOTORS TO UNDER-FLOOR FEEDERS.

cylinder head, disc or other circular piece of work, and it is desired to increase the speed of the spindle as the tool is gradually fed inward to operate upon less diameters, it is only necessary to step up the speed of the motor little by little by turning the controller on the carriage a notch at a time; this the tool operator can do without taking his eyes off of the work, so that not only is no time lost in making the speed changes, but also the maximum possible rate of production is secured.

In the case of the boring mill the controller is mounted upon a conveniently located pedestal bracket at the side of the tool, which is close enough to the table so that the operator may easily reach the same, practically without leaving his work. In this case the nature of the tool and its work is such as to make this arrangement feasible and convenient, the size of the work permitting the operator at all times to be in view of it.

The method of variable-speed operation used is the four-wire, multiple-voltage system of the Crocker-Wheeler Company. This system of tool driving, as is well known, uses four wires between

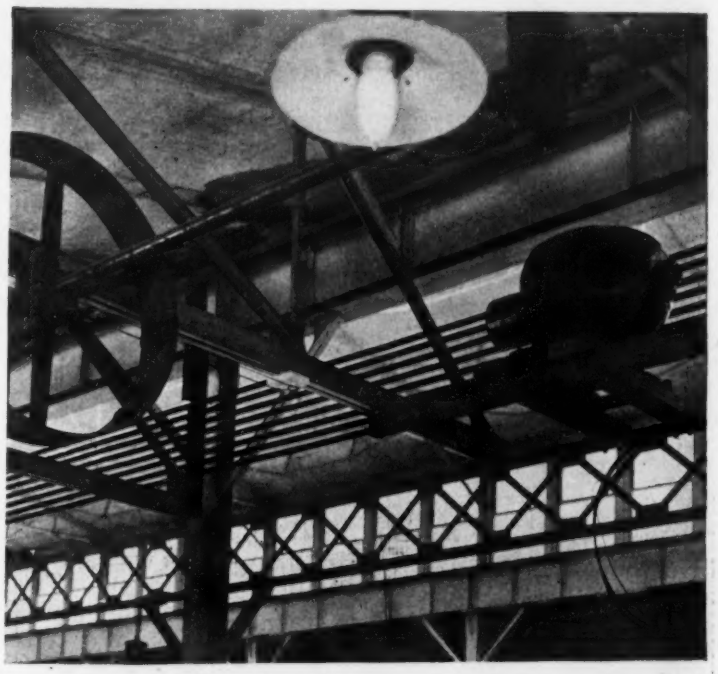


FIG. 6.—DETAILS OF MOTOR MOUNTING FOR A GROUP DRIVE.

which the four main or primary voltages of 40, 80, 120 and 240, and the auxiliary voltages of 160 and 200, may be obtained, the unbalanced intermediate voltages being secured through the agency of a motor-generator balancer set. The type of balancer set used in this installation is of the three-generator type, of which all three machines are mounted upon the same shaft in tandem, with their armatures connected in series across the 240-volt power distribution mains; one of the machines is wound for 40 volts, another for 80 and the third for 120 volts, so that when in operation as motors any one of three may become a generator to supply current at its voltage for balancing the system, when it would be operated by the other two as

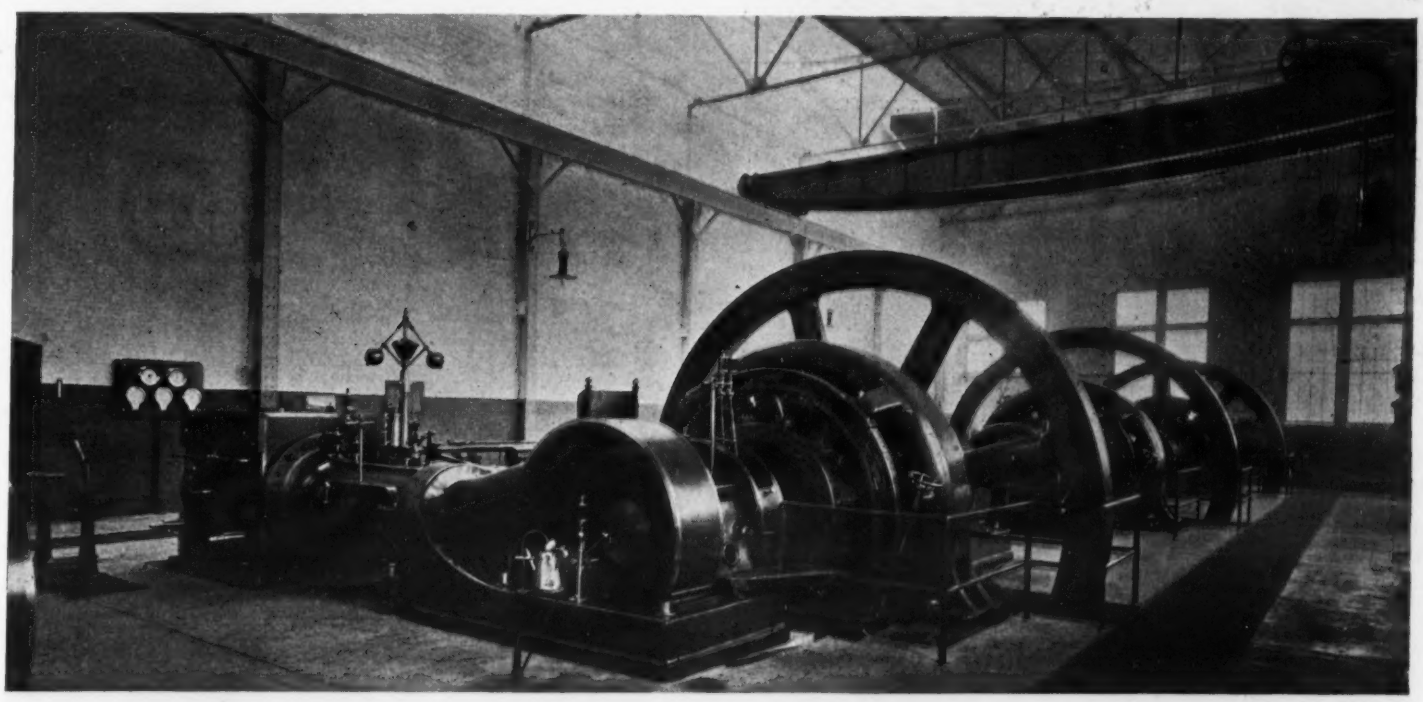


FIG. 7.—VIEW IN THE ENGINE ROOM OF THE POWER PLANT, SHOWING GENERATING UNITS.

motors. In this way the variations among the demand legs of the four-wire system are met primarily through the main 240-volt system, the balancer set distributing the supply and equalizing as required. The operation of the system is automatic and very successful, no trouble being experienced in the balancer sets or at the controllers of the motors, while results in operation of the tools driven are very valuable.

An interesting distribution method is made use of in bringing the power to the various tools in the machine shop. The four wires of the multiple-voltage system are carried through the machine shop beneath the floor in bituminized conduits about 12 in. under the surface, these conduits ending in floor plate openings, adjacent to every building column. The method of tapping the mains for the distribution of current to the nearby machine is, as shown in Fig. 5, that of merely connecting the branch leads to the mains under the floor plate and running them out through a short length of loricated conduit up alongside of the column nearby. This makes a very convenient method of getting at the four wire mains and at the same time does not interfere with shop operations, as the floor box is covered ordinarily by a heavy cast-iron plate. The branch conduit leading up through the floor is in most cases run up alongside the nearby building column, although it is equally possible, if desired to locate the machine half-way between two adjacent columns, to chisel a channel in the concrete floor and locate another

FIG. 8.—VIEW IN THE PIPING AND WIRING TUNNEL.

loricated conduit so as to lead more closely to the machine to be served. This is a valuable feature of the distribution system and one of considerable importance in the application of the motor-driving system.

The older method of driving tools from short line shafts is to be used to a limited extent in some parts of the shop for the operation of some of the smaller and lighter classes of tools, and those which do not require changes of speed. An accompanying illustration (Fig. 6) indicates the method of mounting the motor and belting to the line shaft for such drives. As may be noted, the motor is carried by the existing roof structural work of the building, a light Z-bar being merely bolted between the lower cords of the roof truss upon which two supporting bars are located, in connection with the lattice framework of the building, to carry the motor. Upon this the motor frame is bolted, so that the belt may be tightened by merely adjusting the motor as desired. The motor starting box is then located upon a nearby building column down conveniently near the floor.

The electrical generating equipment in the power plant installation is interesting for its completeness. The power plant is located in a large building in practically the center of the shop cite with subway connections to the various buildings through which all heating and compressed air piping and the electrical wiring is carried. The power plant has been designed with the view of both reliability and economy in service, many features tending toward economical operation as well as modern safeguards having been used. The general arrangement of the plant is that now so generally in use, consisting of parallel boiler and engine rooms separated by the usual fire wall. The architectural features of the building are very plain, yet convenience and strong construction predominate. The foundations are of concrete and under the engine room a spacious and well-lighted basement is provided for access to the steam and exhaust piping and wiring connections to and from the switchboard.

The completed steam plant is designed for 2,500 hp, the boiler capacity at present installed consisting of three batteries of two 250-hp boilers each, giving thus a total of 1,500 boiler hp capacity. The boilers are of the Stirling water-tube type and are fitted with Roney stokers, which are designed to burn a low grade of anthracite slack; very satisfactory results are had by mixing with the slack a very small percentage of bituminous coal, which serves as a binder. Green economizers are used for the heating of the feed water, while the primary heating is accomplished in a Cochrane open feed-water heater, supplied by the Harrison Safety Boiler Works, which is fitted also with a Cochrane oil separator for the removal of the lubricating oil from the exhaust steam.

The electrical generating equipment consists of three 300-kw, direct-connected units and one of 100-kw capacity. The generators in all of these cases are Crocker-Wheeler engine type units, which deliver direct current at a potential of 240 volts. The engines are in all cases of the Cooper-Corliss cross-compound type, those operating the 300-kw generators being each of 450 hp capacity, while that driving the 100-kw machine is of 150 hp capacity. A convenient switchboard arrangement is provided for the operation of the generators in parallel and the control of the power and lighting circuits.

An interesting feature of the plant is the underground tunnel through which the wiring and piping connections are made to the various buildings. Fig. 8 illustrates this tunnel at the point of leaving the power plant, where it divides to connect with different buildings of the plant. The arrangement of wiring is very convenient, metal cross arms being provided upon which the wires are located upon insulators, as in exterior construction. The pipe hanger supports upon the opposite side of the tunnel are also interestingly arranged, provision being made for adjusting them to any height, as desired. The result is a very convenient and workable arrangement by which easy access to the various pipes and cables may be had.

Electric Grain Elevators.

Some tests made at Geelong, Australia, show the economy from electric power in handling grain, aside from the alacrity with which ships may be loaded by the use of electric conveyers. For a practical test, three machines were put in work for 8½ hours, and during that time 42 kw.-hours of current were consumed. At 5 cents per unit the work cost $2.10, a wonderfully low cost when it is considered that no less than 5,320 bags of wheat were handled. It is estimated that a ship with a capacity of 21,000 bags of wheat can be loaded with this system for about $9, while if the elevation to the ship's side were not too great to allow of two or three bags being placed on the belt, the cost of the electricity would be brought down to about $5.

Electric Drive in an English Cotton Mill.

Our London contemporary, the *Electrician*, gives an account of what is claimed to be the first spinning mill in England built from the outset to be driven electrically. The mill is being erected by the Acme Spinning Company, of Pendlebury, near Manchester, and will contain 41,000 mules and 34,000 ring spindles, as well as the usual preparation machinery. It will consist of six stories, and is to be equipped throughout with the most up-to-date appliances known. Supply is to be given by the Lancashire Electric Power Company, from its district power plant. Three-phase current at 10,000 volts will be taken into a special fireproof transformer chamber, and the supply to the motors will be at 400 volts three-phase, while four-wire three-phase distribution at 230 volts will be used for lighting. As turbines are used for driving the dynamos at the power company's generating station, a very perfect drive will be obtained on the spindles. Steam engine makers insist that with their most modern plant no cyclic irregularity occurs; as, however, the new mill is being built side by side with a steam-driven mill of the same proportions and under the same management, a very useful comparison will be instituted.

An Induction-Motor Factory Installation.

THE extreme reliability of the induction motor under all kinds of neglect and misuse has done much to extend the possibilities of the electrical method of distribution of power by motor driving to many industries involving the most severe conditions and unfavorable surroundings. An instance of successful operation of the induction motor under almost impossible conditions is to be seen in the large new electrical generating and distribution system of the New York Glucose Company, at Edgewater, N. J. In this plant over 160 induction motors, ranging in capacity from 10 to 75 hp each, are in use under conditions which in almost all cases would render the operation of line shafts very difficult, not to speak of the impossibility of the use of motors with commutators or exposed contacts. Owing to the large variety of chemical processes necessary in the treatment of the corn for the manufacure of glucose and starch, deleterious fumes of various kinds are constantly present in many departments, in some cases of an acid nature and in others bearing sulphur; again, in other departments dust and dirt is encountered to a remarkable extent, the motors becoming covered and filled almost solid inside the frame. In practically all cases the motors are successfully operated under conditions which would seem utterly impossible for electrical apparatus.

An illustration of a typical drive in this plant is presented in Fig. 1, which shows a 75-hp induction motor driving a large Stilwell-

FIG. 1.—INDUCTION-MOTOR DRIVING A LARGE TRIPLEX PUMP.

Bierce triplex pump of 4,000,000 gallons capacity. This pump is employed for supplying circulating water for the vacuum pans and other cooling processes necessary in the manufacture of glucose and the chemical by-products. The motor is necessarily operated continuously, as much depends upon the constancy of the supply of circulating water. This particular motor is favorably located, being situated in an enclosure on the dock, from which the water supply is pumped from the Hudson River directly. It is operated constantly day and night throughout the year, with the exception of an occasional eight-hour shut-down made on a Sunday for examination of the machinery in the plant.

An interesting illustration of a large group of motors which are similarly operated continuously day and night through the week is presented in Fig. 2. Here eight 30-hp induction motors are mounted upon a platform in the middle of a room from which they drive attrition mills for the grinding of the corn as it enters the plant preparatory to being subjected to the chemical processes. The motors are belted to counter-shafts at the side of the room, from which the attrition mills are driven directly, each of the latter containing two spindles which are driven in opposite directions. The drives are in this case very simple and conveniently arranged in view of the large number of them and of the large power capacity involved. The motors are all controlled by starting boxes on the side walls opposite the mills driven, and in this case the simplicity of this type of motor appears to particular advantage. In this room the apparatus is subjected to an unusual degree of dampness, owing to the presence of vats in the room above in which the corn is soaked; owing to a certain amount of inevitable leakage, water is at all times present so that it is found necessary to protect the starting boxes by individual housings, although the motors are apparently not affected and run continuously when subjected to a veritable flood.

In Fig. 3 three motors of 30 hp capacity in the corn elevator are illustrated, which are interesting owing to their continuous and never-failing operation under the trying conditions of large quantities of

FIG. 2.—A GROUP OF EIGHT MOTORS DRIVING ATTRITION MILLS.

water and also the presence of an excessive amount of sulphur fumes. In this department of the plant one of the processes involved requires the presence of sulphur fumes in large quantities, and this in addition to the presence of large quantities of dust would appear to impose the most severe operating conditions; yet the motors operate continuously and give absolutely no trouble, running day and night throughout the week with no further care or attention than the weekly oiling.

In Figs. 4 and 5 similar instances of the operation of motors in departments filled with fine flying dust are to be noted. These are two sections of the starch department where the cornstarch is being ground or sacked, so that large volumes of a fine, impalpable dust

FIG. 3.—INDUCTION-MOTORS OPERATING IN DIFFICULT SURROUNDINGS.

are given off which, as is well known, is highly susceptible to explosion if fire or a spark of the slightest nature be present. In fact, one of the great difficulties in the operation of machinery in a flour mill or other plant where fine dust of this character is present, has been due to explosions from the presence of even the slightest spark

or flash causing ignition of the dust mixture. Owing to the absence of commutators or exposed contacts of any kind in the induction motor, this danger is entirely obviated and the motors operate continuously in these and other similar departments, without the slightest danger.

Fig. 4 illustrates two 30-hp induction motors in the starch grinding

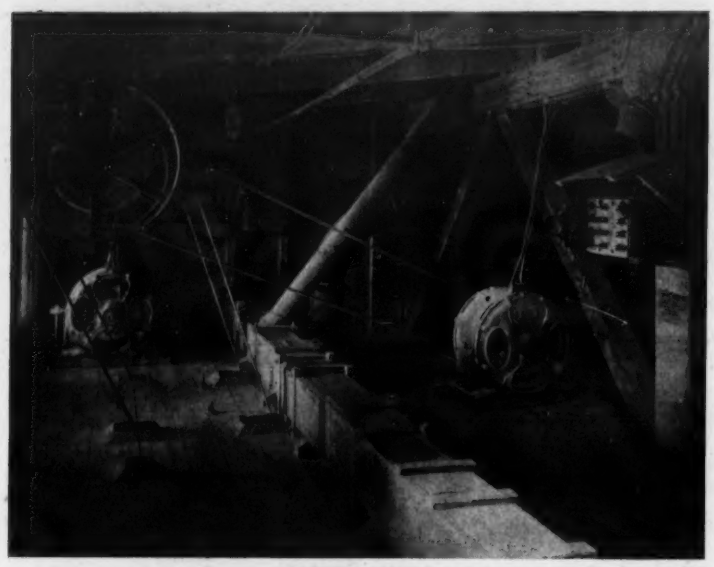


FIG. 4.—INDUCTION-MOTORS UNINTERRUPTED BY PRESENCE OF EXCESSIVE DUST.

department, where the lumpy cornstarch from the drying kilns is ground to the powder form in which it is marketed. The other motor drives a large blower, which is used in connection with the kilns. Both of the machines driven are located upon the floor below, the motor driving, as may be noted, by belting extending to the apparatus below. In Fig. 5 four 20-hp induction motors are illustrated driving exhausters which remove the heated air from the drying kilns. These motors are located upon a shelving carried by the posts in the room, from which they are belted through double reductions to the exhausters. This equipment is in the sacking and storing room, where the automatic sackers and barrel fillers are located, so that large quantities of dust are always present, yet the induction motors are neither affected in any way by the excessive dust accumulations, nor do they involve the fire risk of ignition by a chance spark. The remarkable instance of an induction motor operating under the most severe imaginable conditions of moisture and acid fumes is to be noted in Fig. 6. This is a 20-hp motor driving a screw conveyor in the basement of one of the departments which

FIG. 5.—FOUR MOTORS DRIVING EXHAUSTERS IN DUST-LADEN ROOM.

handles the chemically-treated corn in one of the processes. It is directly beneath two of the large acid steeps, where an acid treatment is given to the material in process of manufacture, and owing to unavoidable leakage of these tanks, owing to their immense size, all apparatus in the basement is necessarily subjected to large quantities of moisture and dampness; the floor is at all times covered with water, sometimes to a very considerable depth. It is, in fact, necessary to keep the motor covered with a sheet metal awning or housing, as may be noted, to keep the water from dripping directly upon it; and the extent to which everything present is subjected to the action of acid fumes may be noted by the dilapidated condition of this awning, which has been nearly eaten through. This motor, however, operates continuously day and night, giving no trouble, and apparently not affected in the least by the acid and moisture. It is thought that the continuous operation of the motor has much to do with its insulation from being affected by the acid. The wires leading to the starting boxes to the motor are, as may be noted, protected by a circular loom conduit, which frees them from a portion of the moisture.

An interesting group of motors of a new type is illustrated in Fig. 7. This illustrates ten 75-hp induction motors of a new vertical type, which were designed especially for this installation for the driving of the stone grinding mills in which a portion of the corn is ground in one of the processes. The stone mills are of the well-known type so commonly used in flour mills, the axes of which are necessarily vertical owing to the character of this grinding process. In order to simplify the drives and also to render the driving arrangements as compact as possible, vertical motors seemed desirable, and the motors illustrated herewith were, accordingly, designed by the Westinghouse Company, especially for this installation. The motor frames are, as may be noted, mounted upon a

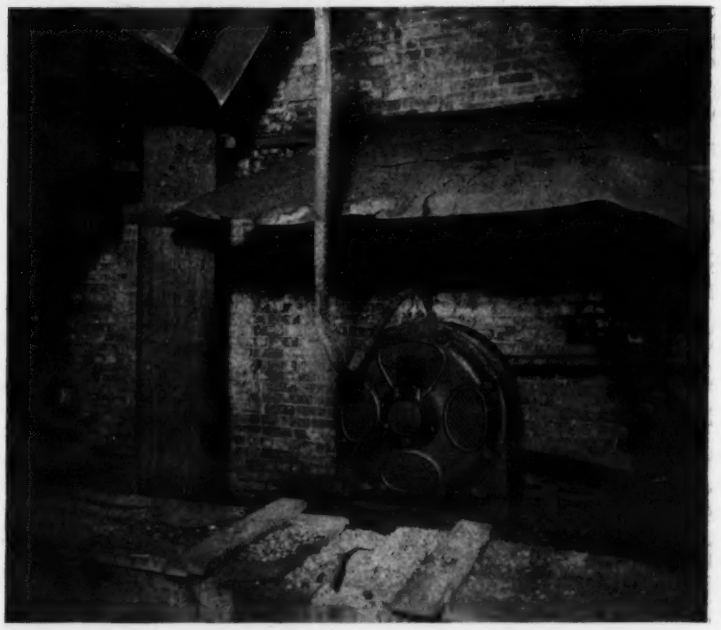


FIG. 6.—A MOTOR OPERATING CONTINUOUSLY THROUGH FREQUENT FLOODS.

special base raising them some 3 ft. above the floor; within the base is located the driving pulley, from which the drive is carried directly to the pulleys upon the stone mills. An interesting feature of these drives is to be noted in the metal canopy above each of the motors, these being provided here also to protect the motors from the water that constantly drips down from the immense starch settling vats upon the floor above. A certain amount of leakage is almost inevitable in an installation of this size, involving dozens of settling vats, each hundreds of feet long. While these canopies free the motors from dripping of water directly upon the revolving parts and windings, they are, however, constantly exposed to moist vapors, yet they operate with absolutely no trouble or interruption.

The system of electrical distribution in this installation was one of considerable magnitude and required careful treatment; owing to the large quantities of moisture present in nearly all portions of the plant, it was deemed advisable to carry all distribution cables on the outside of the buildings. The methods of accomplishing this result are both novel and interesting. Fig. 8 illustrates one side of one of the large buildings of the plant from which an excellent idea of the arrangement of the cables may be had. The cables may be seen to emerge near the basement from the delivery tunnel from the power plant, and rise vertically to the roof; from these risers taps are taken as necessary to enter the building at various points or pass longitudinally along the sides above the windows to the distribution

points. A large structural framework is built upon the wall near the roof from which the vertical risers are supported by strain insulators. The longitudinal leads are carried by brackets of light structural steel construction over the windows.

Two systems of electrical distribution are used in this plant, one for power and the other for lighting. The power circuits are all operated three-phase alternating, while the lighting is two-phase, so that for the former three-wire circuits may be observed, while the latter have four wires. The power cables illustrated in this view (Fig. 8) are very large owing to the quantities of power delivered, varying from 500,000 to 1,000,000 circular mils.

In this connection an interesting form of strain insulator connection was devised by the electrical department of the New York Glucose Company for the supporting of not only the vertical delivery leads, but also for holding the longitudinal leads tight. This departure involves a novel attachment of the ordinary type of strain insulator to the ends of the heavy stranded cables by which a connection of the greatest imaginable strength may be obtained and yet without complication or unsightly bulk. The accompanying sketch (Fig. 9) illustrates the scheme which was devised; it consists of the attachment of a pipe cap to the end of the stranded cable and the securing of this by means of a short nipple and an additional pipe cap to the strain insulator, which as here used is of the usual "Brooklyn" type. The attachment of the pipe cap to the stranded cable is the interesting and effective feature of this arrangement; the insulation upon the cable is stripped back from the end for about an inch and the pipe cap, which has been drilled through the head to the size of the cable core, is then slipped over the core and the strands bent outward within the cap. Then it is evident that when the nipple is screwed in tightly against the frayed ends of the core they will be held there without any possibility of disconnection. This scheme of connecting the strain insulators to the cables was found so entirely successful that it is used throughout the installation and in no case has it failed or shown any signs of weakness.

A special type of distributing panel board was designed for use in this plant, one of which is illustrated in Fig. 10. It consists of a metal framework with slate lining, this combination involving both durability and security from the ever-present dampness resulting from the processes of manufacture employed in this plant. The framework is of metal with angle-iron corners, and the doors are also of metal. The entire box is lined with slate slabs ¼ in. thick at the sides and front, while at the rear a heavier slate panel is used. The box here shown is a panel box controlling the operation of two motors used upon the dock at the river, one a 75-hp induction motor and the other a 20-hp machine. As may be noted, the enclosed type of fuse is used throughout.

A brief reference to the power plant for this large installation may also be of interest. Fig. 11 is an illustration in the engine room, showing the arrangement of the generating units. There are three 800-kw, three-phase, Westinghouse, revolving-field alternators, each of which are direct-connected to Corliss engines; they operate at a frequency of 25 cycles, delivering at 440 volts potential. Each alternator is driven by a double Nordberg-Corliss engine, consisting of a simple cylinder upon each of the generators, with cranks set quartering. Each double engine is of 1,200 hp capacity at the operat-

FIG. 8.—SCHEME OF OUTSIDE WIRING DISTRIBUTION TO THE MOTORS.

FIG. 7.—A NOVEL EQUIPMENT OF VERTICAL INDUCTION-MOTORS DRIVING STONE-GRINDING MILLS.

ing steam pressure of 130 pounds and the rated speed of 98 r.p.m.; the cylinders of the double engine are each 26 in. in diameter, with a 48-in. stroke. The reason that compound or multiple expansion engines were not installed is that the exhaust steam is used for the boiling process in the vacuum pans in the manufacture of the glucose and the by-product chemicals, for which steam at low pressure is required in very large quantities; the three double engines operating simple on each side and exhausting against a back pressure of

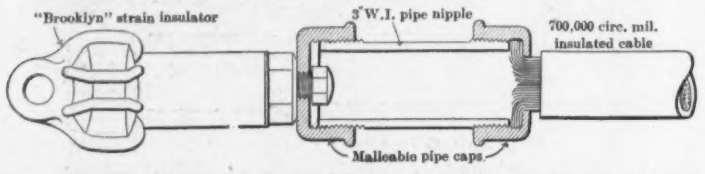


FIG. 9.—NOVEL METHOD OF ATTACHING CABLES TO STRAIN INSULATORS.

approximately 3 pounds are, in fact, barely able to supply the demand for steam.

Duplicate exciter and lighting sets, not shown in this illustration, are also installed, each consisting of an exciter and lighting alternator driven by a Nordberg-Corliss engine operating simple to assist in the supply of the low-pressure steam. The latter engine is of 150 hp capacity, having a cylinder 16 in. by 32 in. in size; it drives through belting both a 37½-kw exciter and a 75-kw, two-phase Westinghouse alternator for the operation of the lighting circuits. The engine-driven exciter is supplemented by a motor-driven exciter consisting of a 50-hp induction motor operated from the main power circuits driving a 37½-kw exciter, both Westinghouse machines; the latter motor-driven exciter operates in parallel with

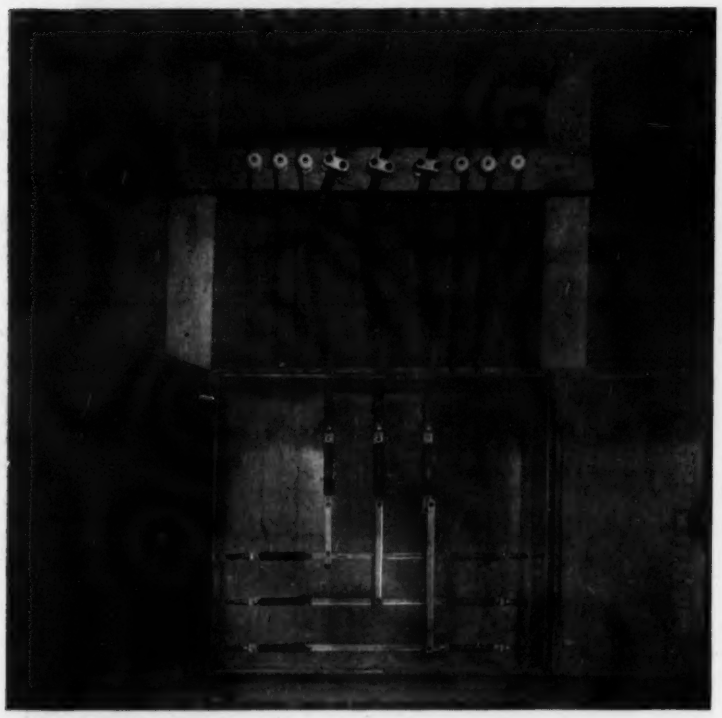


FIG. 10.—A TYPICAL METAL PANEL BOX IN THE DISTRIBUTION SYSTEM.

one of the engine-driven exciters for the operation of the main alternators.

A double switchboard is used for the control of the power and the lighting circuits; the power board consists of nine panels, four of which are for the distribution circuits, three for the alternators and two for the exciters. Of the two exciter panels one is for the two engine-driven exciters and the other for the motor-driven exciter; the exciters are driven in parallel, switching connecting being provided for those controlling them. The distribution panels each carry two circuits, there being in all eight distribution circuits for this purpose. Each of these circuits consumes about 400 amp., the total load being 3,200 amp. almost constantly. It will be noted with interest that the alternators supplying the power circuits are not operated in parallel, this being due to the fact that the load upon all circuits is practically constant, so that little is to be gained by parallel operation. It was found that the load could be very nearly equally distributed between the three generators by the arrangement of circuits that was made, so that satisfactory results are obtained without the necessity of parallel operation, and thus it was argued that unless something was to be gained the risks necessarily incurred in the parallel operation of the alternating-current generators were not warranted.

The lighting board consists of four panels, two for the generators and two for distribution circuits. As above noted, the lighting generators are operated two-phase, the generators delivering at 440 volts, which is stepped down by single-phase transformers to 110 volts at the point of current consumption. The arrangement of these transformers is to be noted in Fig. 8, a group of two being shown upon a platform near the top of the building at the left.

This electrical installation, which involves the constant generation and delivery of nearly 3,500 kw for 160 hours per week for a minimum, consists of 166 induction motors at present in constant operation. The motors range in size from 10 to 75 hp capacity, distributed approximately as follows: Eleven 75-hp, seven 50-hp, fifteen 40-hp, thirty 30-hp, forty 20-hp, thirty-five 15-hp, twenty-five 10-hp. These motors, as well as also the new oil starting switches, were

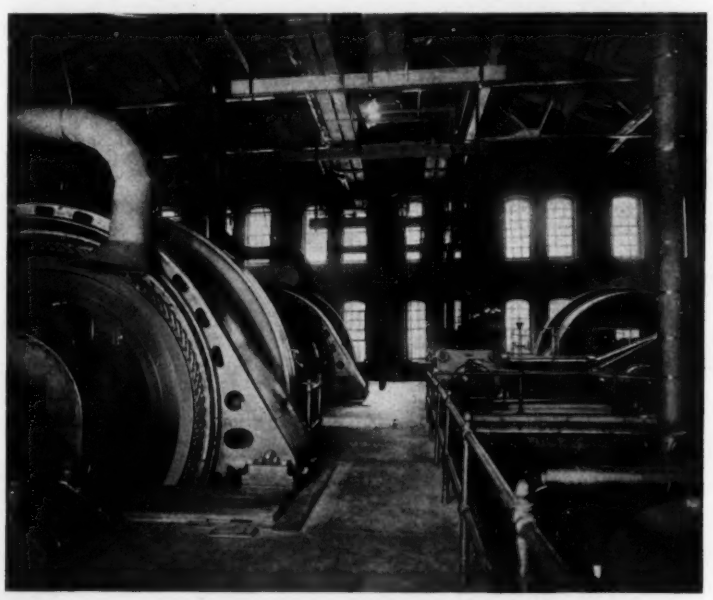


FIG. 11.—THE ENGINE ROOM OF THE POWER PLANT.

supplied by the Westinghouse Electric & Manufacturing Company and were installed by the electrical department of the New York Glucose Company, which is in charge of Mr. Robert J. Woodward. Much credit is due not only to the apparatus, but also to the care that was given to the details of installation of the apparatus, as the results in operation have done much to further the interests and to bring out the possibilities of the electrical system of the distribution of power.

Electric Motors and Machine Shop Requirements.

In a paper before the International Electrical Congress Mr. Charles Day pointed out that to the shop engineer the motor is but a single detail equipment—possibly one of the most important details, but only so when its relation to the problem as a whole is understood. There is no use trying to convince him that the electric motor drive is synonymous with low cost, for he knows that this factor depends upon the co-operation of a multitude of things. If, however, the possibilities of the motor drive are properly presented, he can better appreciate them than any one else, for they fill a definite need, the importance of which he will understand. As to the other side of the question, an intimate knowledge of shop practice in quite as necessary to the designer of electrical apparatus for machine driving as to the builder of the machine. Improved systems of management are doing much to insure proper use of equipment, but apparatus should primarily be designed to give satisfactory results in the hands of average workers. Where its adjustment and manipulation is dependent upon the operator, he must be fully considered in the design, while if attention is required at intervals only, the personal equation does not enter into the problem to as great an extent.

Electric Power Equipment of a Modern Machine Shop.

PERHAPS in no factory in America intended for similar purposes have the details relating to economy and convenience of operation been studied more minutely than in the shops of the Link-Belt Engineering Company, at Nicetown, a suburb of Philadelphia. The electrical equipment of this factory furnishes examples of both individual motor and group driving, each of which has been considered solely on its merit for the particular tool, or set of tools, to be operated.

In the original installation, which was placed in service in 1888, all machine tools were driven by belt from line shafting, in common with the practice of that day. When it was desired to equip the factory with a more economical system of power distribution, the advantages of the various methods of grouping the machines for belt driving and of using single motors for each tool were thoroughly investigated, the outcome being that a number of the smaller machines intended for relatively constant use were conveniently assembled for operation by belt from counter-shafting driven by electric motors, while all larger machines, as well as numerous small ones, were equipped with individual motor drives.

The methods of connection between the motors and the machine tools have in each case been selected with particular reference to the duty of the machine, the convenience of installation and the control of the motor. In many instances the result has been that the main belt wheel has been removed from the driving cone pulley, and there has been substituted therefor a cog-wheel for either direct gearing to, or silent-chain connection with, a direct-current motor of either the constant or variable-speed type. For the purpose of insuring that each tool was worked at its full capacity the requisite strength of the various parts was determined for service conditions, and all weak parts were replaced by ones made of material having greater specific strength or of increased size, so that the machine became of uniform strength throughout its parts, and the driving motor was then selected to deliver the needed power at the desired speeds. The various motors have been mounted mechanically according to the tool to be served, some being supplied with special bedplate castings, each designed to suit its particular machine, while others have been placed upon the floor adjacent to the machine tool. The specific changes made in each case will be more apparent as the machine tool equipments are treated individually in what follows.

Two distinct circuits for electrical power distribution are in use, a three-wire, 115-230-volt circuit used both for lighting and power and a four-wire, 53-70-97-123-167-230-volt circuit used for variable-speed motors. For supplying power to the former circuit, two 115-volt generators connected in series are operated as a unit, while the latter circuit receives power through and by means of a balancer consisting of a combined triple motor-generator set having three armatures wound for 53, 70 and 97 volts, respectively.

For the handling of heavy raw material and the finished and assembled products around the stockyard, there is in use an electric locomotive yard crane as seen in Fig. 1, designed by Dodge and Day, Philadelphia. The feature of particular interest in connection with the crane lies in the means used for transmitting electric power to the moving machine. Along the track traversed by the crane are erected numerous side posts, each supplied with two contact pieces, mounted vertically one above the other, and connected respectively to the positive and the negative generator bus-bars. The locomotive carries four sliding contactor bars, two on either side—sufficient in length to span the distance between adjacent posts. The bars are allowed a certain freedom of motion in a horizontal direction and are held against the posts by means of springs.

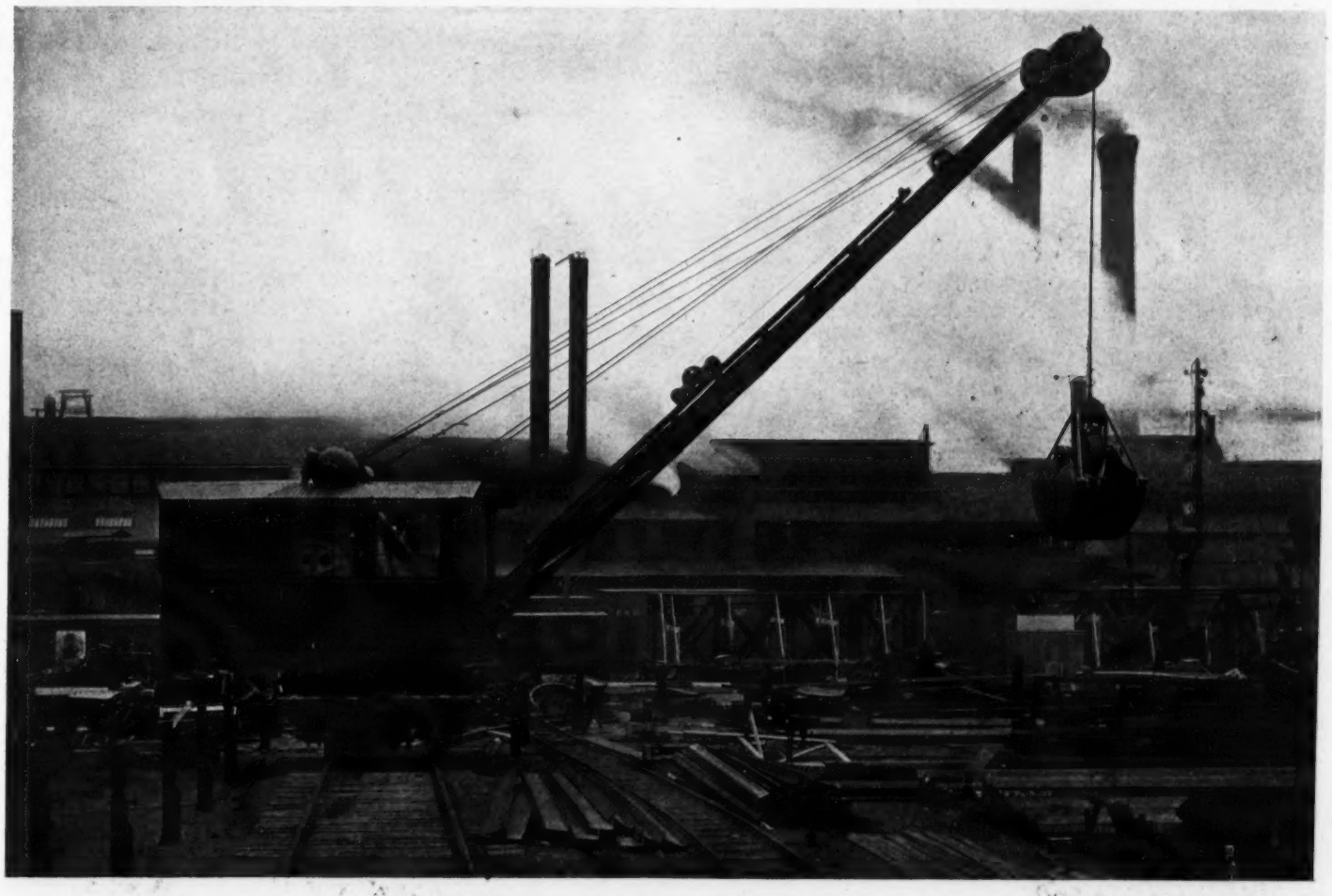


FIG. 1.—ELECTRIC YARD CRANE.

The factory building is in part two stories and in part three stories in height. On the top floor are located engineering offices and photographic rooms, the main floor contains the factory cost accounting, draughting, designing and correspondence departments and the machinery departments, while the basement floor is used for storage of materials and for the sheet metal and assembling rooms.

The space set apart for the machinery department is divided by the supporting columns of the roof trusses into three parts, a center nave and two side aisles. In the central portion, all parts of which are reached by a five-ton Maris electric traveling crane, are placed the heavy machine tools, each operated by a separate motor.

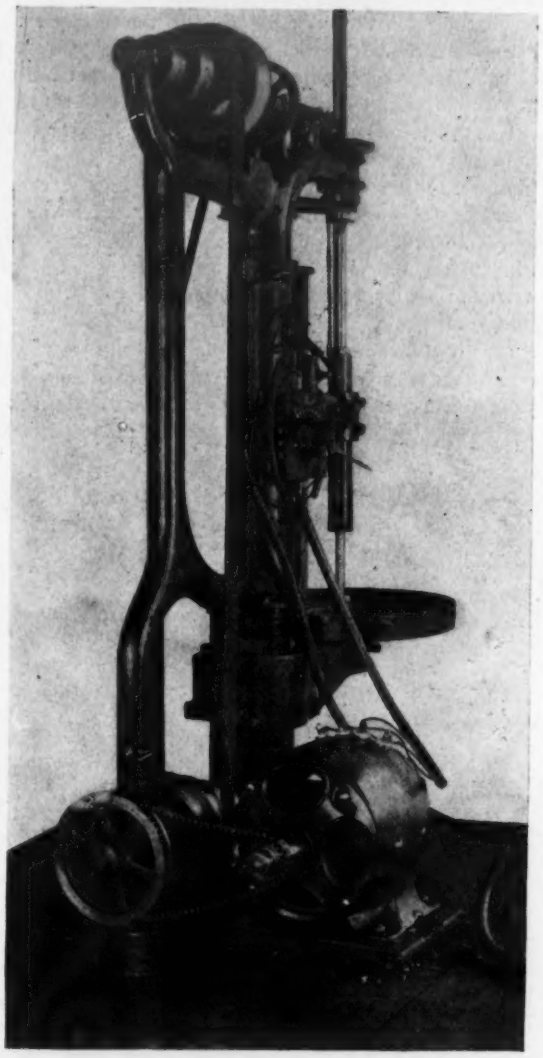


FIG. 2.—2-HP MOTOR ON DRILL PRESS.

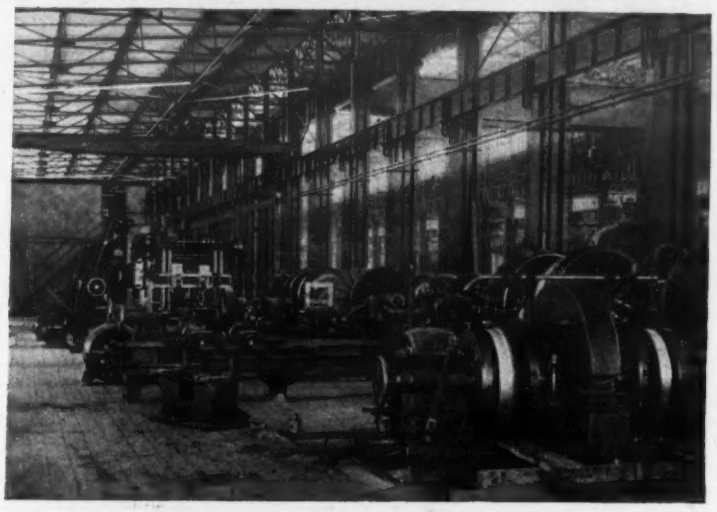


FIG. 4.—INTERIOR OF MACHINE DEPARTMENT.

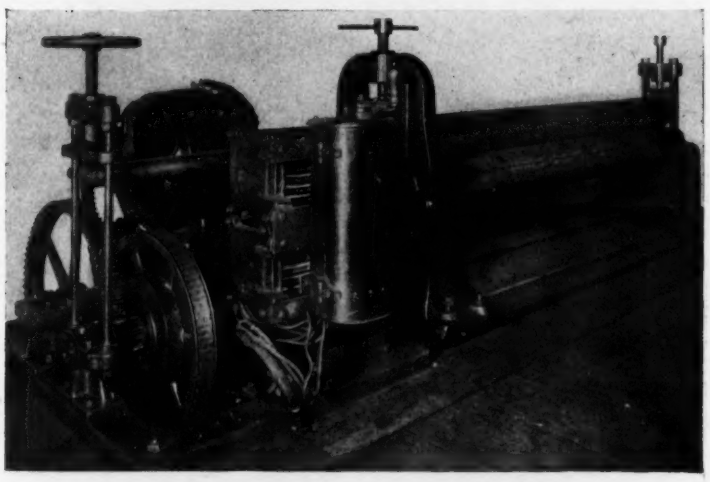


FIG. 5.—BENDING ROLLS DRIVEN BY VARIABLE-SPEED MOTOR.

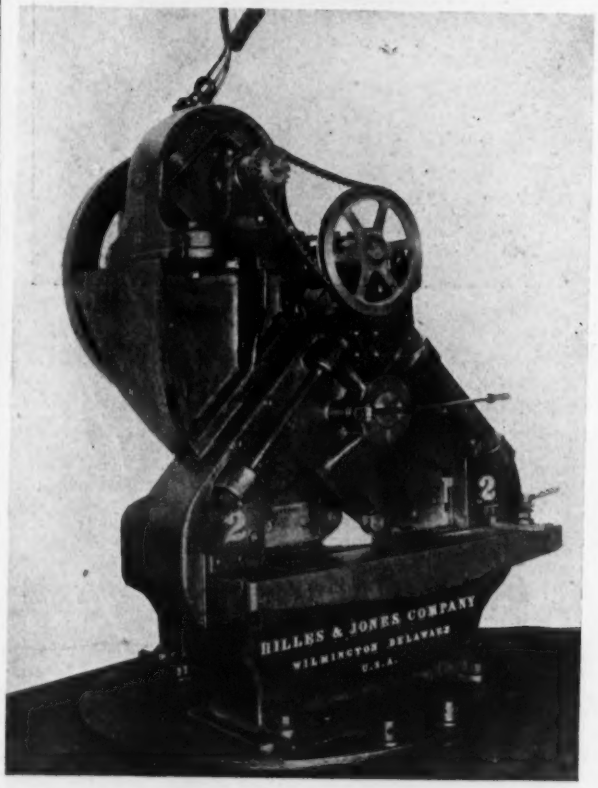


FIG. 3.—SILENT CHAIN DRIVE FOR ANGLE-IRON SHEARS.

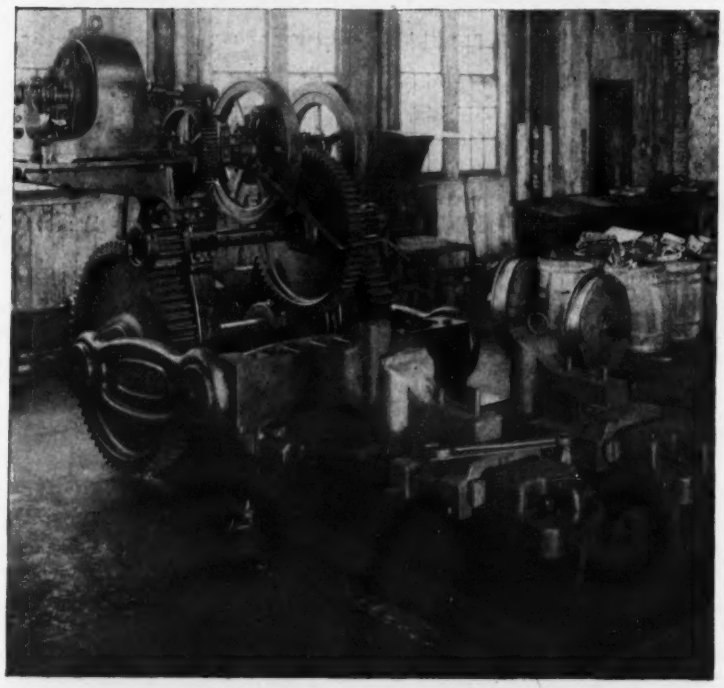


FIG. 6.—BULLDOZER GEARED TO CONSTANT-SPEED MOTOR.

ELECTRIC POWER EQUIPMENT OF A MODERN MACHINE SHOP.

On an 8-ft. lathe made by the Lodge & Shipley Machine Co., Cincinnati, is mounted a 10-hp Bullock variable-speed motor geared directly to the driving cone pulley. The controller is operated by a handle on the carriage connected to a slotted bar running the whole length of the lathe. On the carriage is placed an adjustable bracket from which is suspended an arc lamp which continually follows the cutting tool as the work progresses. A similar 12-hp Bullock motor equipment drives a 25-ft. Lodge & Shipley shaft and screw-cutting lathe. A universal planer made by the Newton Machine Company, Philadelphia, is operated by a 7.5-hp General Electric variable-speed motor connected to the three-wire distributing circuit.

The following tools built by the Pond Machine Company, of Plainfield, N. J., are belt driven by separate motors; a 40-in. radial drill operated by a 9-hp variable-speed Bullock motor placed on the floor near the machine; an 8-ft. planer and four 72-in. universal radial drills belted through the floor to variable-speed motors. An interesting feature of the motor drives for these machines is found in the fact that both the motors and the controllers are placed below the floor in order to economize space. Each controller is operated by a handle rising through the floor and conveniently mounted on a substantial stand which contains a graduated dial for ascertaining the speed at which the motor is running.

In the side aisles, where a number of the smaller machine tools originally installed are yet in use, there are several short lines of shafting driven by belt from electric motors and a large number of tools with individual drives. A 9-hp Bullock variable-speed motor placed on the floor serves to drive through a Renold silent chain a 36-in. Burr lathe. A similar Bullock motor mounted on an extension bedplate and geared to the driving shaft operates a Warner & Swasey drill. A Gould & Eberhardt drill press is driven by a 6-hp variable-speed Bullock motor. The controllers for each of the last three motors are placed below the floor and operated by a conveniently arranged handle.

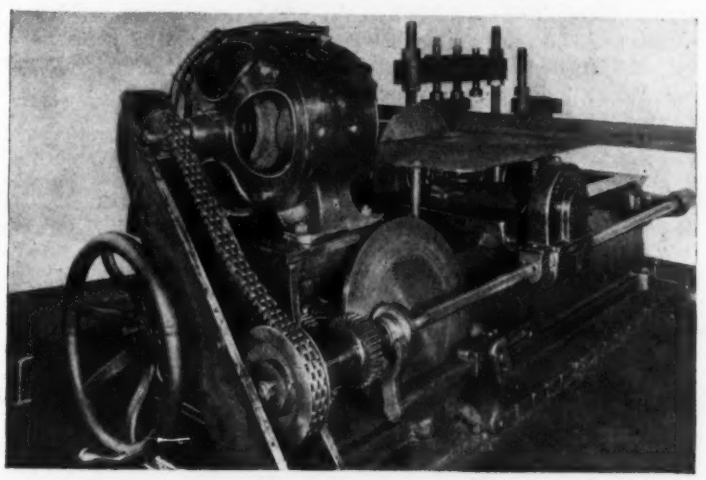


FIG. 7.—SILENT CHAIN DRIVE FOR COLD SAW.

A Pond double-headed boring machine is connected through a Renold silent chain to a 9-hp Bullock motor. Two 3-hp Bullock motors drive separately two Snyder drill presses by means of silent chains. The controllers for these motors are placed on the side of the machine within easy reach of the workmen. Two constant-speed Bullock motors, each of 9 hp capacity, are belted individually to a Smith & Mills 24-in. slotting machine and a Pedric & Ayer universal planer. Each motor is provided with a circuit switch and starting rheostat without speed-changing devices, mechanical means being used for such variation of speed as may be needed.

A 2-hp General Electric motor serves for driving through a Renold silent chain a Blaisdel drill press. A controlling board containing a starting rheostat with automatic no-voltage release is mounted upon the side of the machine, as seen in Fig. 2. A White mechanical riveter is belt-connected to a 1-hp Sprague shunt motor wound for a voltage of 230 and a speed of 1,190 r.p.m. To a small countershaft driven by a C. & C. 2-hp shunt-wound motor are belted a double emery grinder and an automatic iron bolt saw.

The group drives of the iron working machines in the side aisles are served by Bullock constant-speed motors, each equipped with starting rheostat line switch and overload circuit-breaker. They are as follows: A 13-hp motor driving a group of eight lathes and tapping machines; a similar motor equipment operating a Maris elevator, a Pedric & Ayer milling machine, a Pratt & Whitney bolt threader, a Curtis & Curtis pipe threader and a Dodge & Day drill press, and a fourth motor-driven group consisting of four Blair lathes, one Mitts & Merrill tapping machine and a Hendey 30-in. lathe. A view of a corner of one side aisle, showing the overhead traveling cranes is given in Fig 4.

On the same floor with the machine tools for handling iron is located the pattern-making and wood-working department, the chief interest in the electrical motor equipment of which is centered in the method employed for starting a Power & Co. circular rip saw. The automatic starter, which is placed in service by means of a rotary snap switch, brings the motor up to speed at a predetermined rate, on account of a magnetically operated rheostat, the movement of which is dampened by an oil-filled dash-pot. The controller equipment is mounted on the side wall of the building, while the snap switch is placed upon the frame of the saw itself. When it is recalled that such a saw is in actual service for but a small fraction of the total factory working hours, the advantages of this method of control will be apparent. The motor in use is a constant-speed, 8-hp Bullock machine, which is connected to the main shaft of the saw by means of a Renold silent chain drive.

A group of wood-working tools, consisting of a Power planer, a Berry & Orton band saw, a Kidder planer, two Berry & Orton hand speed lathes and one L. Power & Co.'s drill press is belt driven by a 10-hp General Electric motor placed on an overhead platform erected upon the roof trusses. The controlling equipment, which includes a rheostatic starter, overload circuit-breaker and a line switch, is conveniently located on the side wall.

The company maintains a complete testing department in which electrical instruments occupy a conspicuous place. As a source of mechanical power when such is needed, or for use to dissipate a measurable amount of energy for special transmission tests, there are installed two Bullock 12-hp direct-current machines, which can be connected as motors or generators at will. There are available various tension and absorption dynamometers, tachometers, cyclometers, rheostats, circuit-breakers, ammeters, voltmeters and wattmeters, the latter instruments being of the Weston standard make.

As is well known, the Link-Belt Engineering Company is actively engaged in the manufacture of all types of mechanical conveyors. In the construction of such machines there is used a considerable amount of sheet metal, so that many of the heavy machine tools installed in the factory are designed for handling boiler plate material. As mentioned previously, the department for this work is confined to the ground floor. Each tool for this purpose is equipped with a separate motor, most of the machines being of the constant-speed type.

Two 7.5-hp Bullock motors operate by silent chain and by belt, respectively, a Hilles & Jones punching machine and a bending machine of the same manufacture, the motor for the latter being placed on a special platform in the roof girders. A 7.5-hp Bullock motor is mounted on an extension bedplate and geared to a Link-Belt cold cutting shear. A similar motor is placed on top of a Link-Belt plate-bending machine, which it drives by means of a Renold silent chain. A Ferracute punching machine is connected through silent chain to a 10-hp General Electric motor, which runs at a constant speed of 650 r.p.m. A Hilles & Jones roll bender is driven through a Renold silent chain by a variable-speed 7.5-hp General Electric motor, using an R-28 controller giving five forward and five backward speeds (see Fig. 5.)

Two General Electric motors of 2 hp and 5 hp capacity, respectively, drive through silent chain and through belt, respectively, a drill press and an angle-bending machine, while another General Electric motor operates a Newton cold saw to which it is connected through a Renold silent chain, as seen in Fig 7. Two Sturtevant centrifugal blowers are belt driven by General Electric constant-speed motors of 7.5 hp and 10 hp capacity. Each machine is equipped with an I. T. E. circuit-breaker and a main line switch. A 3-hp General Electric motor is mounted on an extension bedplate and directly geared to a Ferracute shear.

To a Hilles & Jones punching machine is connected a 5-hp General Electric motor through a Renold silent chain, as shown in Fig. 8. A Williams, White & Co. bulldozer, a view of which is given in Fig. 6, is geared to a 20-h-p. Westinghouse constant-speed motor, which is mounted on a special bedplate casting. A 5-hp Gen-

eral Electric motor drives a link-belt drill press by means of a Renold silent chain.

A 10-hp Westinghouse compound-wound motor is connected through silent chain to a Hilles & Jones angle shear (see Fig. 3). Tests have shown that the silent chain drive was 15 per cent. more economical of power than the gear drive, which was in use with the earlier equipment.

Adjacent to the main factory building is located the boiler house, the steam generating equipment of which at present consists of four Babcock & Wilcox boilers having an aggregate capacity of 500 hp. These boilers are fired by hand, and are considerably overworked. It is the intention soon to add to the boiler equipment, for which purpose a temporary end wall will be removed and the building extended in that direction. A motor-driven ash conveyor serves to elevate the ashes from a receptacle below the boiler house floor, in which they are dumped, to a hopper from which they are lowered by gravity to emptied coal cars, as frequently as desired.

The power house contains six 115-volt, compound-wound, direct-current generators of the General Electric make. These are operated in three separate sets of two each. The original power set consisted of two 75-kw machines driven at 280 r.p.m. by direct connection to a vertical cross-compound engine built by the A. D. Granger

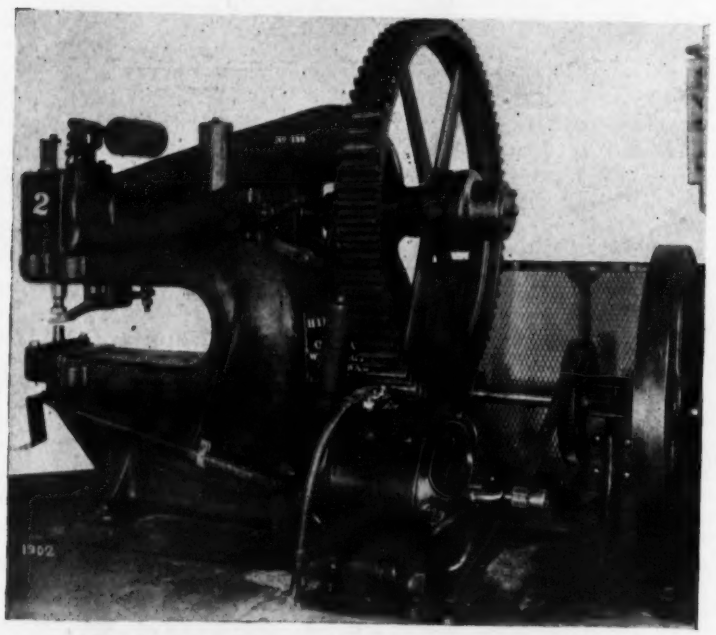


FIG. 8.—PUNCHING MACHINE DRIVEN BY CONSTANT-SPEED MOTOR.

Company, New York, which is equipped with a National speed limit made by the Monarch Manufacturing Company, Waterbury, Conn. A second set included in the present power equipment consists of two 100-kw generators directly driven by a vertical cross-compound Buckeye engine. A night set, used only for illumination when the factory has ceased operation, is formed of two 13.5-kw generators connected through Renold silent chains to a Westinghouse standard vertical engine.

The balancer set, which has been referred to previously, is of Bullock manufacture, and is designed for a speed of 875 r.p.m. It contains three armature windings, but only two field cores. Externally considered, the balancer is composed of two direct-connected machines mounted on a common bedplate. One machine is designed for 97 volts and 310 amp., while the other, a double-current machine, is designed for 53 volts, 214 amp. at one commutator and 70 volts, 208 amp. at the other. The armature windings of the latter machine are mechanically superposed and placed in the same slots though being electrically isolated.

The switchboard contains 13 panels, arranged in order of location, as follows: Four lighting, six generator, two power and one gauge panel. It is worthy of note that, contrary to former practice, the generator panels are placed in the middle of the board. This method was adopted as being the preferable one in most cases, since of the three general classes of panels in common use, those for the power circuits, the lighting circuits and the generator circuits, the two classes likely to need room for expansion, the power and the lighting, should be at the ends of the board, requiring that the generator panels be placed at the center. On two of the panels above designated as being of the generator class are mounted two Thomson recording watt-hour meters, each of 2,500 amp. capacity, connected in the outer main bus-bars for determining the total amount of energy. Frequent readings of the various switchboard instruments are taken by the attendant and systematically recorded in a log book so that the distribution of power generated can be ascertained at any time.

Only the three main leads—the positive, the neutral and the negative—of the separate generator sets are brought to the switchboard, so that a total of three triple-pole switches serve for connecting all six generators to the main bus-bars, the equalizing leads being brought to three double-pole switches mounted on the same number of stands near the machines. A separate voltmeter is provided for each machine, so that the task of paralleling the generators of the separate sets is rendered comparatively easy, while the readings of the individual ammeters in the outer leads from each generator serve to indicate the division of load between the different sets. One of the so-called power panels contains a starting rheostat and indicating meters for the motor-generator balancer. The gauge panel contains eight gauges, for steam, air and water, as follows: One steam, one back pressure, one fire service, one main air, two receiver pressure and two air compressor. The air, which is used for operating pneumatic chippers, drills and riveters, and is piped to each machine tool for cleansing purposes, is supplied from two steam-driven Norwalk compressors, the receivers being old-style return tubular boilers, which had been discarded from the original boiler installation.

The power, distributing and motor equipments of the factory were selected upon recommendations of Dodge & Day, who designed many of the details involved in the numerous changes which were made, and who are yet in entire charge of the equipments as installed. To these engineers, and to Mr. Kern Dodge especially, are we indebted for numerous courtesies and valuable assistance in the preparation of this article.

Variable-Speed Motor Equipment of a Motor Factory.

AN interesting development in the equipment of motor-driven machine tools is to be found in the factory of the Electro-Dynamic Company at Bayonne, N. J., interior views of which are shown in Figs. 1 and 3. The building is a two-story brick structure provided with an abundance of lighting area in the side walls, and a vertical skylight in the roof. An electric traveling crane traverses the full length of the building and serves for conveying heavy materials to various machine tools in the main central portion of the building. The small tools are grouped along the side aisles of both the first and second stories.

While numerous lathes, drills, slotters and similar tools are yet driven by belt from line shafting, the equipment is rapidly being changed over to individual motor drives, a number of boring mills, radial drills, turret lathes and other larger machines being at present provided with separate motors. In general in rearranging the drive for the drills one cone pulley has been omitted and the other belted directly to the motor, or both have been removed and a special pulley substituted for the driving core. For the lathes similar means have been used in some cases, while in others gearing and silent chain driving have been employed. Typical methods of power transmission between machine tools and the driving motors are shown in Figs. 1 and 7. Fig. 1 gives a view of a variable-speed motor directly geared to a Bickford radial drill, while Fig. 7 illustrates a 21-in. Bement-Miles slotter driven through a silent chain by a variable-speed motor, the controller for which is mounted directly on the machine itself.

The particular feature of interest in these equipments resides in the means employed for obtaining variable speed from the motor itself throughout a range as great as 400 per cent. without sparking at the commutator. In a test of a certain 5-hp motor, which the writer recently witnessed in the factory, the speed of the motor was increased from its lowest value of 275 r.p.m. to 1,100 r.p.m., under a load 100 per cent. greater than normal, without producing any sign of sparking, and when the motor was suddenly reversed under full load the same results were observed. The satisfactory performance of the motor under such severe conditions is attributable to the special field construction which is used in these machines. The

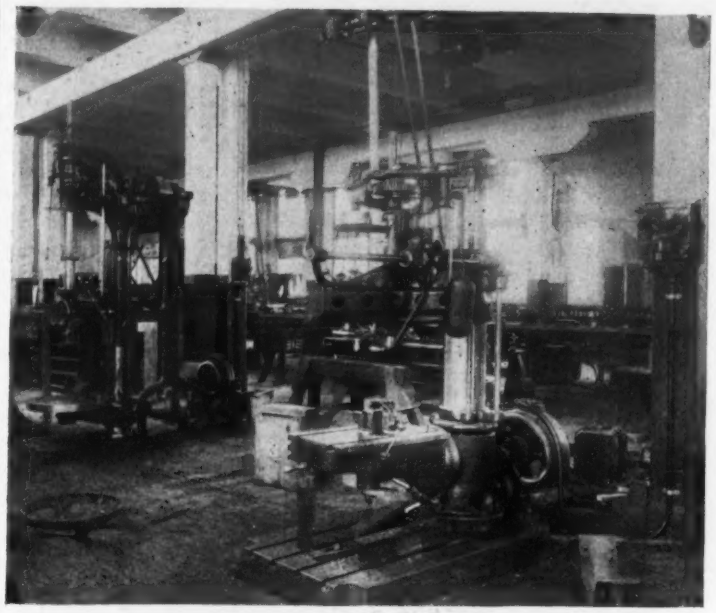


FIG. 1.—MOTOR-DRIVEN RADIAL DRILL IN CENTER AISLE.

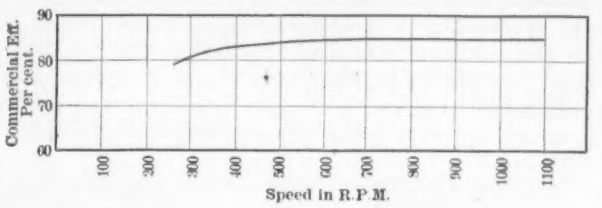


FIG. 4.—EFFICIENCY OF 5-HP MOTOR AT FULL LOAD.

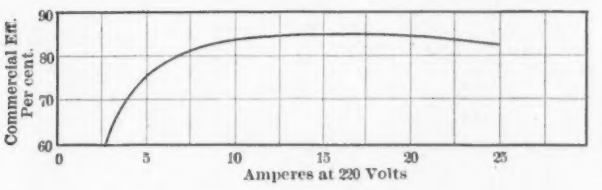


FIG. 5.—EFFICIENCY OF 5-HP MOTOR AT 750 R.P.M.

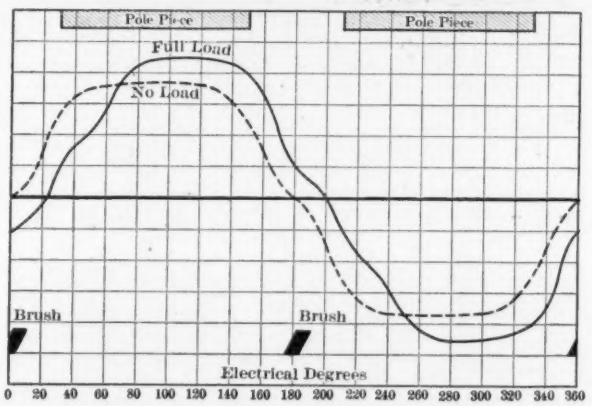


FIG. 2—DISTRIBUTION OF MAGNETIC FLUX AT NO LOAD AND FULL LOAD WITHOUT INTER-POLES.

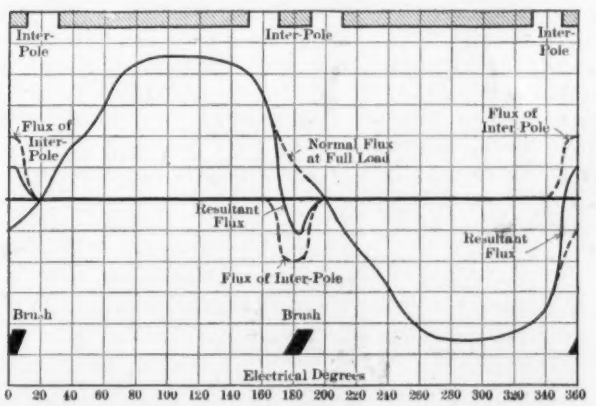


FIG. 6.—DISTRIBUTION OF MAGNETIC FLUX AT FULL LOAD, WITH AND WITHOUT INTER-POLES.

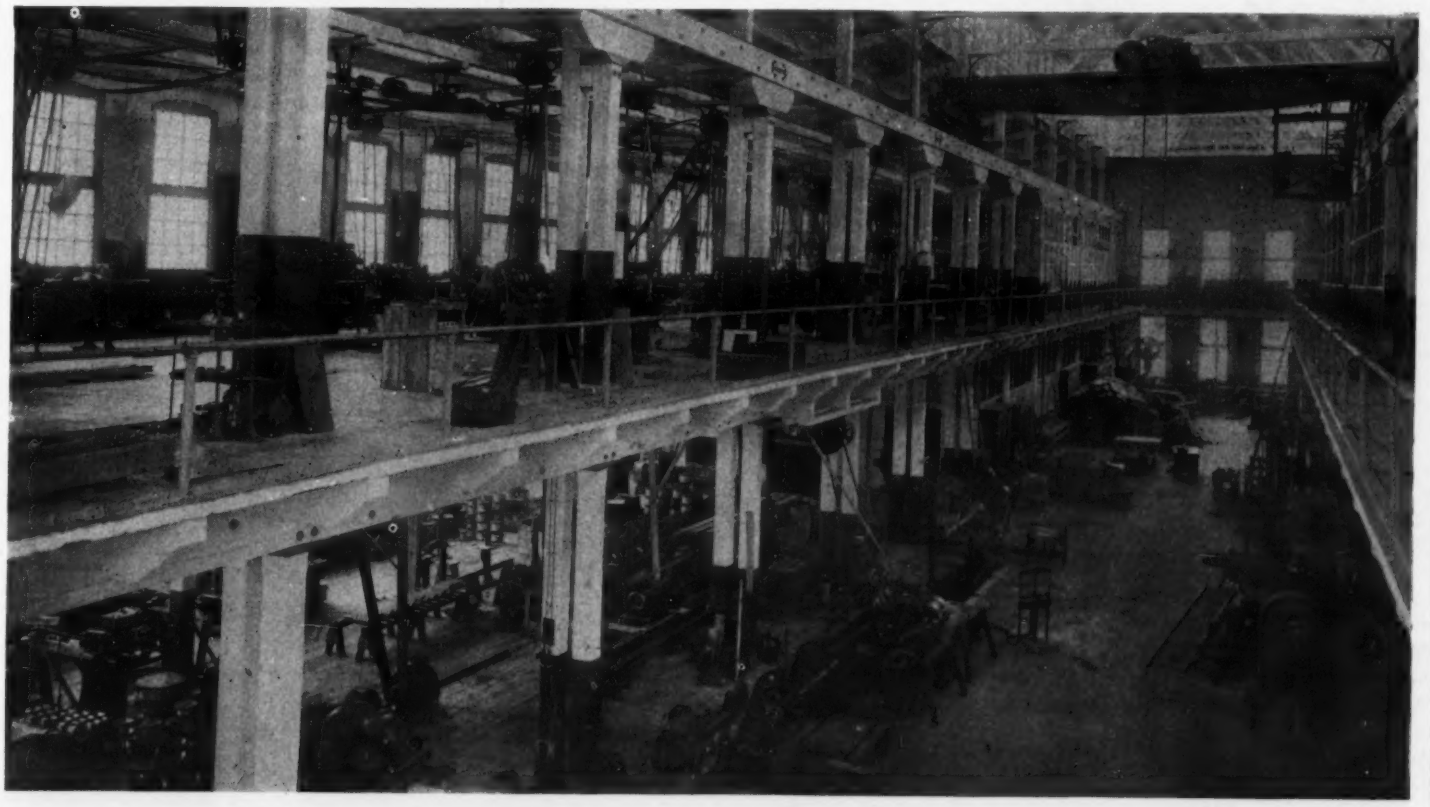


FIG. 3.—CENTER AISLE OF FACTORY.

VARIABLE-SPEED MOTOR EQUIPMENT OF A MOTOR FACTORY.

shops of the Electro-Dynamic Company were designed with especial reference to the manufacture of motors for machine tools, and the company is supplying its own motor equipment for the tools, using for this purpose the new inter-pole machines, concerning which descriptions have recently appeared in these columns. Much additional information with reference to the performance of these machines is now available, and the curves presented herewith should prove interesting in this connection.

The novel construction used in these machines, which permits of the performance indicated above, resides in the employment of auxiliary poles placed between the main field poles and excited by means of the main line current. The object of these interposed poles is to cause the generation, within the armature coil under commutation, of an e.m.f. of the proper value and sign to reverse the current in the coil while it is yet under the brush—a result which is essential to perfect commutation.

The field distortion due to the m.m.f. of the armature current is too well known to admit of comment. A brief review of the attendant phenomena may, however, not be out of place. The variation in the flux distribution in the air-gap of a commercial direct-current machine of the former well-known type, due to the load current, is shown relatively by the curves of Fig. 2.

Consider the value and position of the flux in the coil under the brush when the machine is operating at full load. The motion of the armature through this flux causes the generation within the coil of an e.m.f. proportional to the relative speed, and the sign of this e.m.f. is such as to tend to cause the current in the coil to continue to flow in the direction which it had before the coil reached the brush, and hence it opposes the desired reversal of the current before the coil leaves the brush. There is at play an additional detrimental influence which would tend to retard the rapid reversal of the current, even though all other influences were absent. This latter influence is due to the local magnetizing effect of the current in the

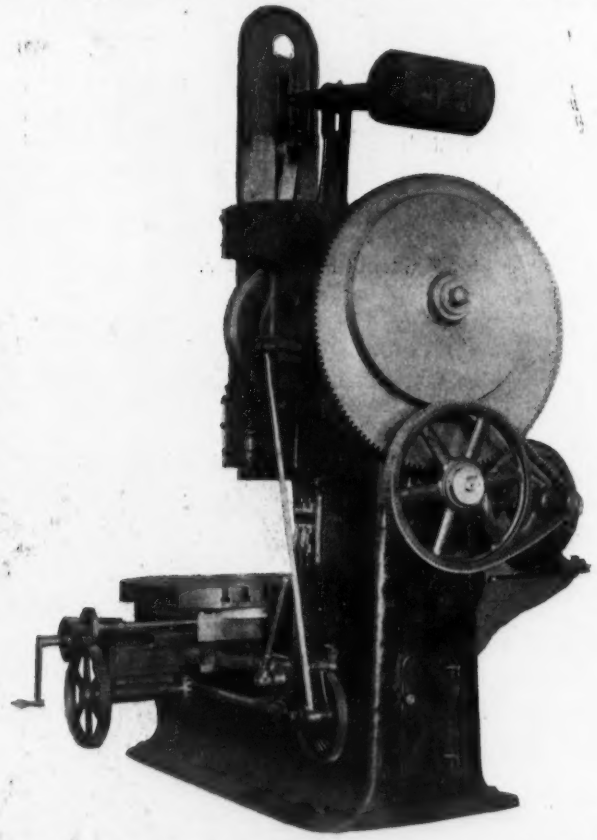


FIG. 7.—INTER-POLE MOTOR DIRECT-CONNECTED TO SLOTTER.

coil under the brush, on account of which there surround the conductors lines of force the change in the value of which with the fluctuation of the current as it tends to be reversed generates in the coil an e.m.f. which opposes the change in the current. This reactive e.m.f. is in the same direction as that due to the cutting of the flux by the coil under the brush, and is likewise proportional to the speed.

It will be apparent that even were the field distortion completely neutralized the detrimental reactive e.m.f. would yet remain. The improved and practically perfect commutation of the inter-pole motor is due to the fact that the flux which is locally superposed upon the main field not only counterbalances the undesirable main flux cut by the coil under the brush, but it causes to be generated within the coil an e.m.f. sufficient to equal and oppose the reactive e.m.f. referred to above. This effect will be appreciated from a study of Fig. 6, which represents the distorted flux for the motor of usual design, as shown in Fig. 2, and indicates the result to be expected when the flux due to auxiliary poles is given the relatively proper value.

It is worthy of note that this desirable effect is the more pronounced the weaker is the field, and that the commutation voltage, if correct for a low speed, is correct for a high speed, and that with increase of load current and main field distortion there is a proportional increase of counter magnetizing field produced in the coil

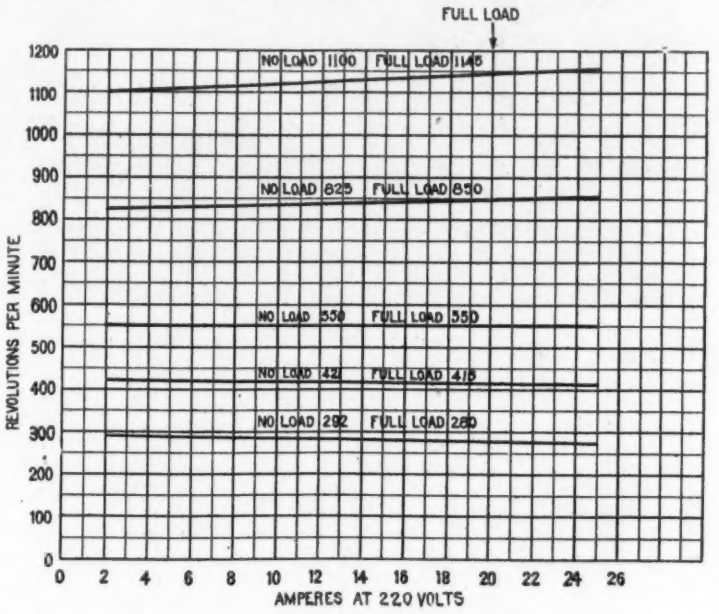

FULL LOAD
NO LOAD 1100 FULL LOAD 1145
NO LOAD 825 FULL LOAD 850
NO LOAD 550 FULL LOAD 550
NO LOAD 421 FULL LOAD 415
NO LOAD 292 FULL LOAD 280
REVOLUTIONS PER MINUTE
0 100 200 300 400 500 600 700 800 900 1000 1100 1200
0 2 4 6 8 10 12 14 16 18 20 22 24 26
AMPERES AT 220 VOLTS

FIG. 8.—REGULATION CURVES OF VARIABLE-SPEED MOTOR.

under the brush, up to the point of magnetic saturation of the auxiliary poles, and that sparkless commutation is insured for all operating ranges both of speed and load.

It is evident that, by shifting the brushes from the neutral points, the magnetism in the auxiliary poles may be caused to add to or subtract from the total flux active in producing counter e.m.f's between the main brushes, and that thereby the machine may be given the speed characteristics of either a compound or a differential-wound machine. Obviously, with a given setting of the brushes away from the neutral points, the magnetism introduced by the auxiliary poles will be of relatively a greater value compared with the flux of the main field poles when the latter poles are weak than when they are strong, and that the compound or differential effect will be greater the higher the speed. It is found that, in placing the brushes for a differential effect it is possible so to adjust the angle from the neutral points that the increase of speed with the weakest main field may be made just equal to the decrease of speed with the strongest main field and that, for a certain main field strength, the speed is practically constant for all loads. The speed curves of Fig. 8 taken from test of a 5-hp motor, serve to show this characteristic throughout the whole operating range of the machine.

The inter-pole motor is equipped with Hess-Bright ball bearings, the friction of which in comparison with other losses is found to be practically negligible. A description of this type of bearing was given in ELECTRICAL WORLD AND ENGINEER, February 18, 1905. An interesting feature in connection with the method of application of these bearings to the motor in question is to be found in the fact that neither are the outer tracks for the balls rigidly connected to the end bells, nor are the inner tracks solidly fastened to the shaft, a light drive fit without key ways being sufficient in machining the parts. The bearing equipment is extremely simple, and although no means whatever are provided for adjusting for wear, the makers feel justified in guaranteeing a life of ten years.

Fig 4 shows the efficiency of the machine at full load for various speeds; that is, for various adjustments of the main field strength. Although the efficiency is relatively constant throughout a large range, it will be observed that at the lower speeds it drops off slightly. This result is attributable to the increase of hysteresis loss at the higher magnetic density in the armature core, the eddy-

current losses being independent of the change in magnetic flux with counter change in speed, and the slight increase of friction and windage at the higher speeds being inappreciable.

The efficiency of the same machine at various loads at a mean speed of about 750 r.p.m. is represented in Fig. 5. The drooping of the curve at the full load of 20 amp. shows a low value of constant losses and relatively higher value of variable losses, indicating low iron and high copper loss. The fact that even a large value of m.m.f. due to the current is in no wise detrimental to the commutation of the machine, allows the placing on the armature of what, for ordinary practice, would be considered an excess of copper; in fact, the armature core may be slotted to a depth at least double that used for other machines, thereby permitting a more efficient use of the core material. Since the depth of the air-gap is not a determining factor in the commutation, it may be made as small as mechanical clearance alone will permit, and, therefore, the field m.m.f. may be kept quite small and the whole structure made much lighter than that usually found with variable-speed motors.

Electric Motor Equipment of the Worthington Hydraulic Works.

THE new Henry R. Worthington plant of the International Steam Pump Company, recently completed, is one of the largest and most modern manufacturing plants in the world. It is situated on the rise of ground just beyond the Hackensack Meadows in Harrison, N. J., a location which, owing to its natural and shipping facilities, seems destined to become one of the largest manufacturing centers in the vicinity of New York City. All the buildings are of steel and brick construction and the arrangement is such that a maximum production may be obtained with a minimum amount of handling. The object of the company was to obtain a continuous sequence of operations from the foundry to the shipping department,

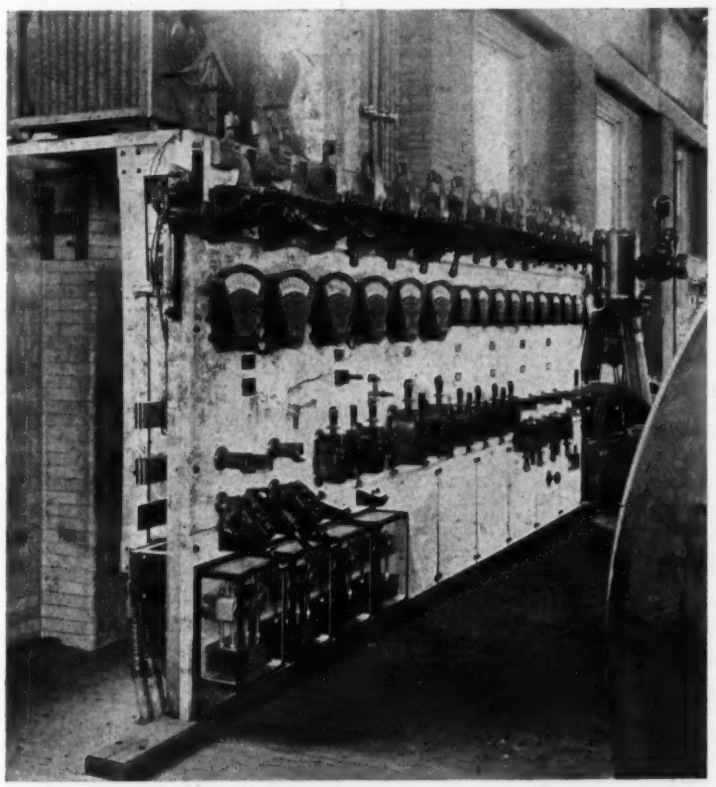


FIG. 1.—POWER STATION SWITCHBOARD.

and to avoid hand labor wherever possible. The apparatus manufactured at this plant comprises reciprocating and centrifugal pumps, condensers and water meters of the plunger and disc type.

The electrical generating plant is located in the northeastern portion of the company's property. The building is 100 ft. by 172 ft. and at present has installed therein six 300-hp Babcock & Wilcox boilers, furnishing steam for 750-hp horizontal cross-compound Corliss engines of the Providence Engineering Company's make. These engines are run condensing, exhausting into a Worthington self-cooling central condensing plant, of the surface condenser type, in connection with a cooling tower, so arranged as to be used with natural as well as artificial draft. Each engine is direct-connected to a 500-kw General Electric three-wire generator running at 150 r.p.m.

The generators supply current for both power and lighting at potentials of 125 and 250 volts in a very ingenious manner. A neutral wire is brought from compensating transformers connected to quarter-phase slip rings at the back of the armature, the lower

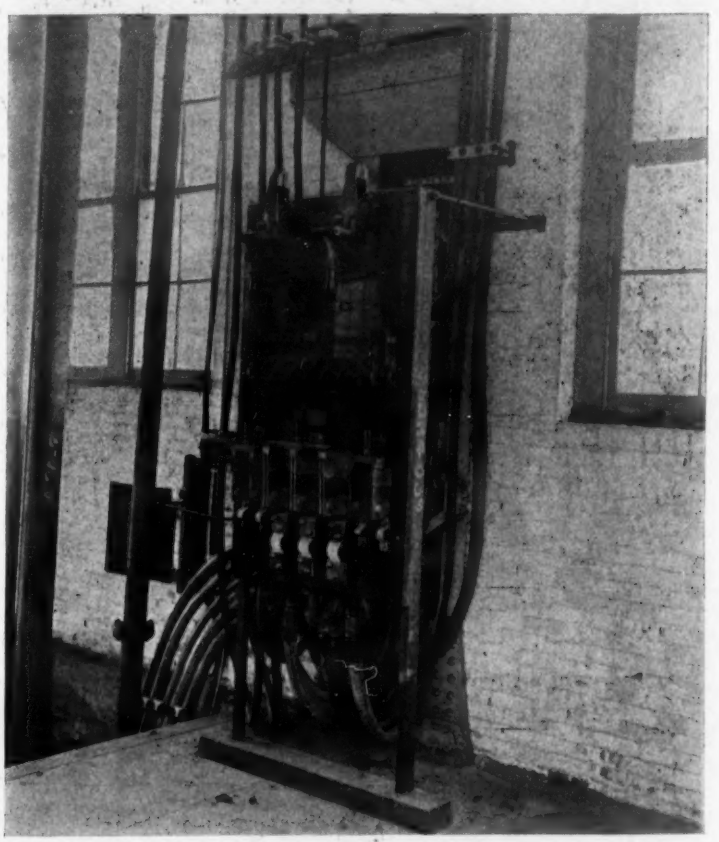


FIG. 2.—ONE OF THE DISTRIBUTION PANELS.

voltage being obtained between this neutral and either wire coming from the 250-volt commutator. The lower potential is used to supply the lights and the higher voltage to supply the motors. With this arrangement the copper necessary for the conductors is kept down to a minimum.

The switchboard (Fig. 1), which is of blue Vermont marble, has two generator panels and several feeder panels. It is equipped with the largest types of safety devices and electrical measuring instruments, and is so arranged that all distribution is under the immediate and complete control of the switchboard attendant. The power to each building can be independently thrown on or off, and either generator can be thrown into or out of service, without in any way disturbing the other generator or the general system.

All the main feeders from the switchboard are lead-covered cables, carried underground to the various buildings by means of a tunnel and system of vitrified conduits. The tunnel is of concrete 6 ft. wide by 6 ft. deep and runs from the power station down the central avenue between the buildings, with branches into the machine, erecting, testing and shipping buildings. From the center of the tunnel vitrified conduits extend to the several foundry buildings; through these conduits the main feeders, before mentioned, are led.

At the point of entrance to a building the main feeders terminate at a distribution panel (Fig. 2), equipped with proper switches and automatic safety devices. From this panel all circuits within that particular building can be independently or collectively controlled. The power and lighting circuits are entirely separate and not dependent one upon the other after leaving the distributing panel.

The lighting of the plant is accomplished almost entirely by the use of arc lamps, the conditions and arrangement having been so thoroughly studied that very few individual incandescent lamps were found necessary.

Such lighting was made possible by the use of enclosed arc lamps

fitted with a device marketed by the General Electric Company and known as "concentric diffusers." These diffusers consist of round discs of sheet metal pressed into undulating concentric rings and throughout the plant. This, however, does not include the lamps used in the immense electrically-illuminated sign, spelling the company's name, situated on the top of the high erecting shop about

FIG. 3.—VIEW OF INTERIOR OF FOUNDRY.

FIG. 4.—GENERAL VIEW OF MACHINE SHOP FROM NORTHWEST END.

covered with white enamel. They are attached to the lamps in the same manner as shades and so deflect and diffuse the light rays as to give a soft and even light with practically no shadow.

There are about 750 arc and only about 160 incandescent lamps 100 ft. above the ground. Of these 160 incandescent lamps most are used with portable leaders and shades in the machine and erecting shops for obtaining light inside of castings when boring steam or water cylinders or placing valve seats, etc.

The foundries, situated at the southern portion of the plant, consist of a main iron foundry, a brass foundry and a moulding machine foundry.

The main foundry is 140 ft. wide by 600 ft. long and is composed of three bays, a center bay 60 ft. wide and two side bays, each 40 ft. wide. Each bay is spanned by electric traveling cranes, of which there are two of 20 tons, and two of 30 tons capacity in the main bay, and five 10-ton cranes in each side bay. All are of the latest type manufactured by the Niles Tool Company and fitted with General Electric motors and controllers.

In the right-hand center of the building are two 50-ton Paxton cupolas fed from a charging floor 40 ft. wide by 60 ft. long to which material is brought by means of a hydraulic elevator from the pig iron yard in the rear. The blast for these cupolas is furnished by individual positive rotary blowers driven by slow-speed motors located in an enclosed blower room at the side of the cupolas.

At the south end of the building, beyond the cupolas, are the

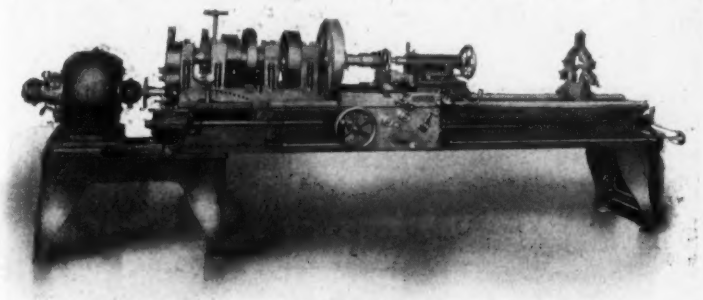


FIG. 5.—LODGE AND SHIPLEY ENGINE LATHE EQUIPPED WITH "RHEOCRAT."

sand sheds where the sand is properly and thoroughly mixed by motor-driven sand mixers and conveyed to bins ready for distribution for any part of the foundry.

The tumbler and cleaning rooms connect the three foundries at their west ends. Here are situated the tumbler barrels belted to a counter-shaft driven by a motor, the sand blasts, each with its own blower and motor, and the emery wheels with their individual drives.

ing machines, situated near the outside walls, and the pouring floor with its industrial tracks in the center.

In this building there are 25 light bridge cranes, 10½ ft. long, running across the shop and equipped with pneumatic and Sprague

FIG. 7.—GROUP OF POND RADIAL DRILLS ELECTRICALLY DRIVEN.

electric hoists of two tons capacity, for handling the flasks, ladles, etc. The main floor is fitted with iron gratings similar to those in the cleaning room floor of the main foundry, which allows the burnt sand to fall to the basement below; this basement extends under the entire building. Here the sand is collected and shoveled into the hoppers of sand elevators which carry it up and dump it ready for the moulding machines again. These elevators are driven by

FIG. 6.—BORING MILLS IN MAIN MACHINE SHOP.

The moulding machine foundry, situated at the extreme southern part of the plant, is 66 ft. wide by 408 ft. long and contains two 40-ton Paxton cupolas equipped similarly to those in the main foundry. Fig. 3 shows an interior view of this building taken from the west end. At the east end are the two core rooms with modern core ovens, where both men and women are employed in making cores. The rest of the building is occupied by the pneumatic moulding machines, situated near the outside walls, and the pouring floor with its industrial tracks in the center.

small motors and can be started and stopped at will by the operators of the moulding machines.

This foundry is one of the largest and most complete of its class, tons of metal being poured daily. It is thoroughly lighted with 35 enclosed arc lamps in the main room and with incandescent lamps in the lavatories and basement.

Between the main and moulding machine foundries is the brass

foundry 90 ft. by 150 ft. long, equipped with two Swortz and one Rockwell oil furnaces. Here all of the brass and alloy castings are made and as the work is of a light nature only a smal crane is used in the main bay and overhead trolley tracks with pneumatic hoists in the side bays.

Each furnace is supplied with its individual blower and motor as is also the washer and tumbler barrel, thus making each a unit by itself.

From the foundries the castings, as soon as cleaned, are sent to the machine shop on cars over the industrial tracks, and there machined and forwarded to the erecting shop.

The machine shop on the western boundary of the property is 121½ ft. wide by 1,008 ft. long and is one of the largest in the world. It is composed of a center and two side bays. The center bay is 50 ft. high to the peak of the roof and 61½ ft. wide and is spanned by four 20-ton Niles traveling cranes running the full length of the shop and equipped with General Electric motors and controllers. The side bays are each 30 ft. wide and two stories high, the second story making a gallery opening on to the center bay. Each side bay is equipped with six 5-ton cranes running the full length of the building directly under the galleries, and used for placing the work in the machines as well as carrying it to and from them. Transportation from the main bay to the galleries is very much facilitated by the use of five 5-ton hydraulic plunger elevators.

The heavier tools, such as the large milling machines, planers, boring mills and drills, are placed in the main bay just outside of the crane columns, while the smaller tools are placed under the galleries in two rows, one next the side wall and the other next to the column. Fig. 4 will give a very good idea of the arrangement.

On the main floor there are about 200 machine tools of various makes, each driven by its individual motor, while in the galleries, where the very light work is done and the automatic machinery is placed, the machines are grouped and belted to line shafting and each group or department driven by a motor.

When the design of the machine shop equipment and the layout of the tools were under consideration a great deal of study was required by the company engineers to perfect the details and to arrive at the best solutions for equipment, control and arrangement.

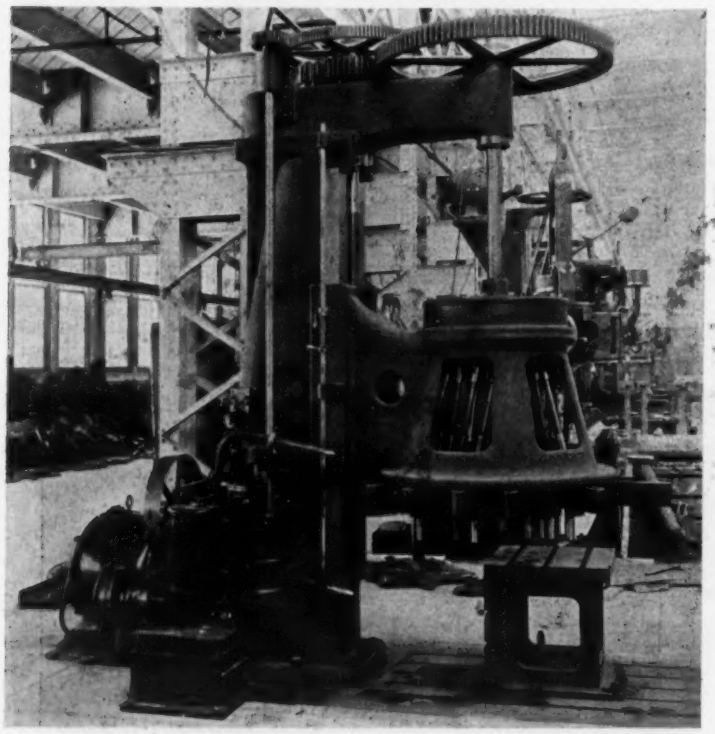


FIG. 8.—17-SPINDLE MULTIPLE DRILL.

They, however, decided to modernize the better part of the equipment at the old plant and add such new tools as the conditions demanded; to group them first according to the work required of them; second, that a rough casting starting at one end would become the finished article at the other, and third, that all of the tools on the ground floor should be equipped with individual motors, so that free use of overhead cranes could be made to facilitate handling and transportation.

The most important question, however, was regarding the method of control and after much deliberation and careful investigation of the various variable-speed systems it was decided to use the field control method of the General Electric Company. The tools, therefore, are equipped throughout with General Electric motors and controllers, with exceptions where, instead of controllers, "Rheocrats" made by the American Electric & Controller Company are used.

Some representative examples of how the motors and controllers were applied are shown in Figs. 6 to 10. Each tool is a unit in itself,

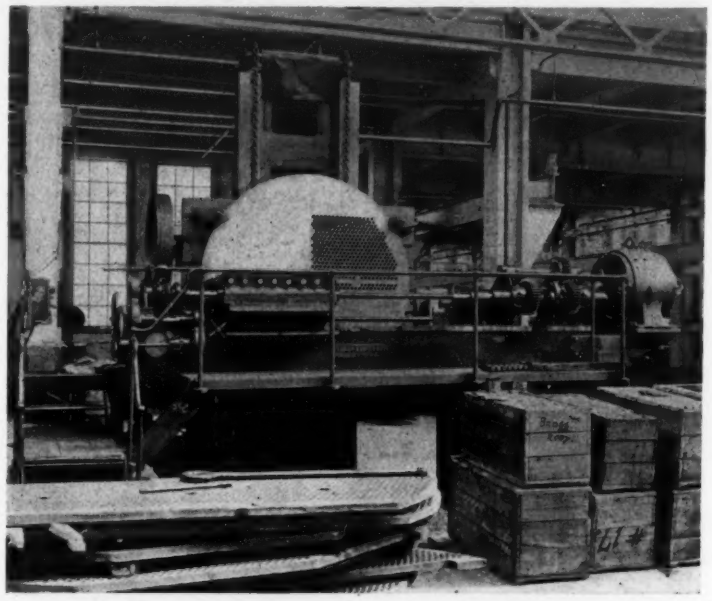


FIG. 9.—HORIZONTAL GANG DRILL ELECTRICALLY DRIVEN.

with the motor attached in a firm and compact manner with the controller always within easy reach of the operator.

The amount of electrical variation obtained varies with the different tools. Machines requiring only 50 per cent. variation were equipped for that variation and those requiring 200 to 300 per cent. variation were equipped with motors to give that variation. In this manner the first cost was kept at a minimum, and allows of no idle capital in the equipment.

On the ground floor of the main machine shop are about 60 machine tools requiring wide variation in speed and comprising horizontal and vertical boring mills, radial drills, large lathes and special tools. These are equipped with General Electric motors having in most cases a field control of 2 to 1. All these are controlled by the "Rheocrat" above mentioned. This controller, besides providing for variation in the motor field, gives an additional 2½ to 1 range in speeds through armature control. Fig. 5 shows a Lodge & Shipley lathe giving variable speed by the use of the "Rheocrat" controller. With the regular counter-shaft drive provided by the builders of the lathe, the spindle is given a speed range from 17 to 372 r.p.m. The number of changes are only nine and are procured either by clutches in the counter-shaft or changing the gears in the head, in the latter case the workman having to leave his position at the work, and in either case the lathe has to be stopped. The present method of operating the lathe by a constant-speed motor and "Rheocrat" procures a speed range from 9 to 820 r.p.m. at the spindle, the number of changes being 150, only six of which had been made through the gearing in the head; the remainder are controlled from the apron of the lathe without the workman having to leave his position.

The low erecting shop is of similar construction to the machine shop, being of the same width but only 600 ft. long. Here the assembling and erecting is done and a visitor may find at any time hundreds of pumps of all descriptions and in all stages of completion.

In addition to the assembling, it is proposed to test all the centrifugal and electrically-driven pumps in this department. There is a large tank or cistern situated under the floor and as soon as a pump is completed it is tested at the maximum duty and under conditions similar to those in actual practice.

In the west gallery of this building is the storeroom, where the finished stock is kept. The other gallery is given up to the repair and electrical departments. The building is equipped with one 10 and one 15-ton Niles crane in the center bay and three hydraulic elevators to the galleries to facilitate transportation. It is lighted

with 32 General Electric enclosed arc lamps in the center bay, 17 in each side bay, and 26 in the east gallery, each fitted with a concentric light diffuser; there are 88 incandescent lamps in the storeroom. Here, as in the machine shop, the columns and side walls are fitted with outlet receptacles for the attachment of portable lights whenever necessary.

The high erecting shop is 200 ft. long, four stories high, and connects the machine and low erecting shops. The center span is fitted with a 30-ton Sellars crane with a lifting distance of 60 ft. and here all of the immense triple-expansion triplex pumps for municipal and marine plants are erected and tested before shipment. In three of the galleries are situated the tool room, the brass shop and the polishing room, the others being given up to bench work. In diagonally opposite corners of this shop are placed electric elevators made by the Otis Company, which facilitate to a marked degree the handling of apparatus.

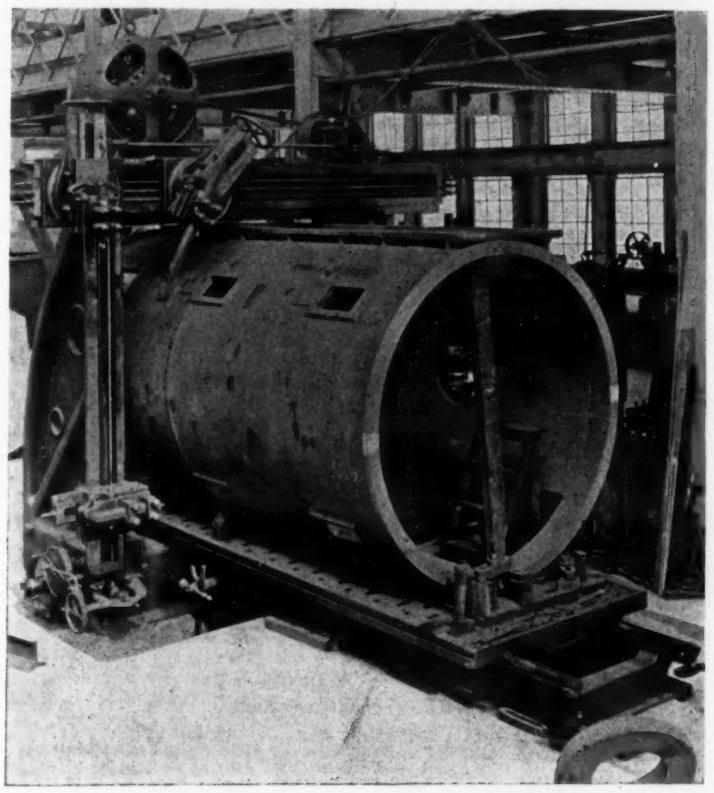


FIG. 10.—PLANER ELECTRICALLY OPERATED.

Each of the galleries is lighted with 12 General Electric enclosed arc lamps fitted with concentric light diffusers, while the center bay is illuminated by 14 lamps of the same kind fitted with powerful mirror reflectors. The result is a striking example of the adaptability of the modern arc lamp to shop lighting.

The testing and shipping departments are located in a building situated between the low erecting shop and the power station. At present it is in an unfinished condition and the testing of both the steam and the electrically-driven pumps is done in the low erecting shop. As soon as the building is completed, however, all of the steam pumps will be thoroughly tested here and then painted and boxed ready for shipment.

This building as well as the low erecting and machine shops is fitted with standard gauge tracks by means of which cars can be run in and loaded or unloaded with the traveling cranes which traverse the full length of the building.

The office proper, occupying the four floors of the northern end of the general office building is equipped with fire-proof vaults and the many accessories found in modern offices. On the third floor is situated a restaurant for the use of the shop and office employees, a lecture room and private reception rooms. The fourth floor is entirely occupied by the drafting room with its electric blue printing department in the rear, where hundreds of blue prints are turned out each week.

The perfect diffusion of the light may be attributed to the fact that the lamps are placed vertically 70 feet above the floor, as well as to the peculiar construction of the corrugated reflector which was referred to previously.

New Telephone Patents.

COMMON BATTERY EXCHANGE SYSTEMS.

Mr. W. M. Davis, of Chicago, has obtained a patent for a two-wire system, of which the distinctive features lie in the busy test. With such two-wire systems, wherein the sleeves of the spring jacks serve the double purpose of line connection and test ring, the usual busy test is not satisfactory, as the subscribers talking upon a connection hear the busy test click each time either of their lines is tested. To avoid this, the test potential is made to operate a high resistance test relay. The current shunted through this relay is of such insignificant amount as to be unnoticeable to the talking subscribers. On the other hand, it is insufficient to produce a direct audible test for the operator. To overcome this, the induction coil of the operator's set is given a testing winding which is included in a local circuit with battery and the contacts of the test relay. Mr. Davis has arranged his cord circuit so that when the listening key is thrown, the busy test circuit is cut in. The Stromberg-Carlson Company has obtained this patent by assignment.

Another system has been patented by D. W. Campbell, of La Crosse, Wis. In this system, current is fed to the lines through impedance coils, the calling and answering cords being connected for talking purposes through condensers. The system provides the usual signals. While the detailed arrangements may be novel, there seems to be no prominent feature of novelty.

A third system is the invention of I. Kitsee, of Philadelphia. This is shown in conventional diagram in Fig. 1. With such a system, cut-off relays are dispensed with, the two sides of a repeating coil being introduced respectively into the circuits of the two subscribers. It is easy to conceive of standard apparatus adapted to the common-return system shown, but it seems probable that a full metallic system would fail because of the necessary complexity of jacks and plugs.

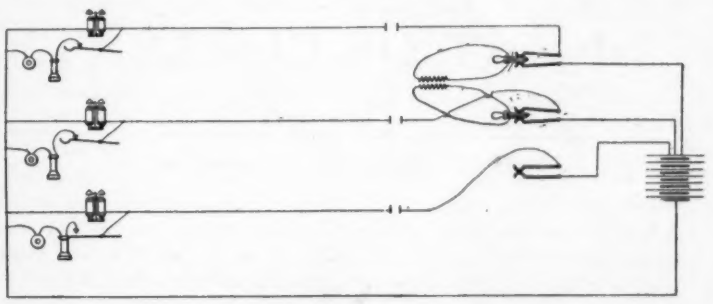


FIG. 1.—KITSEE COMMON BATTERY SYSTEM.

FOUR-PARTY SELECTIVE SYSTEM.

Rather an innovation in the operation of pulsating current four-party selective systems has been made by Garrison Babcock, of Chicago, by the introduction of a direct-current hand-generator for signaling the exchange. In this system, as usual, the bells are polarized and biased to respond to impulses of one sign. Two bells, oppositely poled, are legged off each side of the line to ground. Then, as usual, a selection is effected by distinguishing between positive and negative impulses and between the two sides of the line. For signaling the central office, a direct-current hand generator is provided at each sub-station. This is poled to correspond to the bell. Thus, when current is generated, the bell will give a single tap at each generation of current. No other bell will respond, as not only is the other bell of the same side of the line wrongly poled, but in addition the automatic switch of the generator grounds the opposite limb of the line, thus effectively shielding both its bells from the current. The Stromberg Carlson Company has been assigned the patent for this system.

ANTISEPTIC DEVICE.

A rather new departure in sheet of paper antiseptic devices is the subject of a recent patent. The papers are cut and placed in a loose pad in the pendant casing. The paper is held by a spring against a knurled roll having a thumb nut. Turning the nut throws one sheet from the pad up across the transmitter mouthpiece. S. M. Slocum, of Boston, Mass., is the patentee of this device.

LETTERS TO THE EDITORS.

The Use of Trees in Wireless Telegraphy.

To the Editors of Electrical World and Engineer:

SIRS: While the letter by Mr. John M. Blake in your issue of February 11 is interesting, I must confess that I cannot attach technical importance to his experiments. If, as Mr. Blake has shown, a wire is drawn over the crown of trees, and the ends of the wire connected with a receiving apparatus for wireless telegraphy, the conditions are not materially different from those of a wireless installation with an artificial mast. Therefore, if things are otherwise properly arranged, it may be expected with certainty that the signals of stations within the sphere of action will be received. Consequently Mr. Blake's experiments hardly contain anything of importance to an expert. The trees are simply a substitute for the artificial mast. Nevertheless, I think it quite useful to point to the possibility of utilizing trees in this manner.

Highly interesting from a scientific point of view are the observations of Major G. O. Squier, who succeeded in utilizing trees as antennæ. Though the ability of trees to absorb energy has been known for a long time, I have been surprised to learn that their capacity for absorbing energy should be so great as to be sufficient to make them wave detectors. I fully endorse, however, your opinion in regard to the technical value of this observation, when you say "The results reported hardly bear the inference that a tree would be used successfully as a ready-made antenna for long-distance wireless telegraphy."

BERLIN, GERMANY. DR. GEORG SEIBT.

A Novel Electrical Experience.

To the Editors of Electrical World and Engineer:

SIRS: Last week some of my students were experimenting with a Voss and with a twenty-inch Wimshurst machine in accordance with letters that appeared in *Nature* on the reversal of polarity that accompanies reversal of rotation. A few days later, I wanted the machine for Lodge's syntonic-jar experiment and found it, notwithstanding the reversals, in good working order. As a trial test, the spark-balls were set at a distance of three inches. One discharge passed and that was taken, as usual, to be satisfactory evidence of the efficiency of the machine. When, however, the connections for the syntonic experiment were made and the handle of the machine turned, the result was blank disappointment, there being no charge whatever on the prime conductor. An inquiry was immediately started which soon led up to the cause of failure, *viz.*, the perforation of both condensers. The machine has been in use since 1896 during which time the rectitude of its behavior elicited frequent and well-deserved encomiums from those who had to use it.

MANHATTAN COLLEGE, NEW YORK. B. POTAMIAN.

DIGEST OF CURRENT ELECTRICAL LITERATURE

DYNAMOS, MOTORS AND TRANSFORMERS.

Armature Coils and Ozone.—BUECHI.—A communication on this subject which has been repeatedly discussed recently in the correspondence columns of this journal. As was noticed in the Digest, Highfield has come to the conclusion that coils become defective in actual use, owing to the air left inside the micanite tubes, and thinks that it is impossible to produce a satisfactory winding if any air is admitted between the copper, iron and insulation. The present author does not concur in this conclusion since otherwise similar trouble would have been experienced in various high-tension machines in continental Europe. In his experience, troubles have arisen when the designer has taken advantage of the excellent insulation of the closed micanite tube to economize in the amount of insulation on the actual conductors themselves. Where defects have become apparent after more or less lengthy periods of working, the insulation of a number of the conductors has been damaged at various points, and constant leakage of current has taken place from conductor to conductor. The above defects can be entirely avoided by using ample insulation on the individual conductors and a suitable type of winding. It is of the utmost importance that materials of the very best quality should be used in the varnishes and insulating coverings. He has often found that oxidation of the copper has taken place owing to the use of an inferior quality of shellac which has not been free from acid.—Lond. *Elec.*, February 17.

Eddy-Current Losses in Solid Pole Shoes.—RUEDENBERG.—A mathematical article in which he develops a formula for the losses in solid pole shoes, applying to this problem the theory of electric oscillations. His formula is considered to be sufficiently correct as long as the speed of the slots passing over the pole shoes is not too high or too low.—*Elek. Zeit.*, February 23.

Efficiency of Direct-Current Machines.—VALDINE.—An illustrated article, with analytical calculations, on the determination of the commercial efficiency of direct-current machines by a method the essential point of which is to supply two equal machines connected in parallel from a storage battery, one machine running as motor, the other as generator.—*L'Industrie Elec.*, January 25.

Diseases of Electrical Machinery.—CROCKER AND WHEELER.—An illustrated article on the faults in electrical machinery. The article treats of the causes of sparking at commutator, with their symptoms and remedies.—*Am. Elec.*, March.

LIGHTS AND LIGHTING.

Osmium Lamp.—BLAU.—His illustrated paper in full, an abstract of which was recently noticed in the Digest. The trade name of the osmium incandescent lamp is "Auer-Os Lamp" (from the inventor, Auer von Welsbach). The author first discusses briefly the laws of radiation and then gives an outline of the difficulties encountered by Welsbach in making osmium filaments. The present method of making them is as follows: The starting material is very finely divided osmium which is mixed with organic binding materials so as to form a thick, tough paste, which is pressed under very high pressure through an aperture. A thread is thereby obtained which is formed into loops. The threads are then dried and are heated in the absence of air in order to carburize the binding material, and

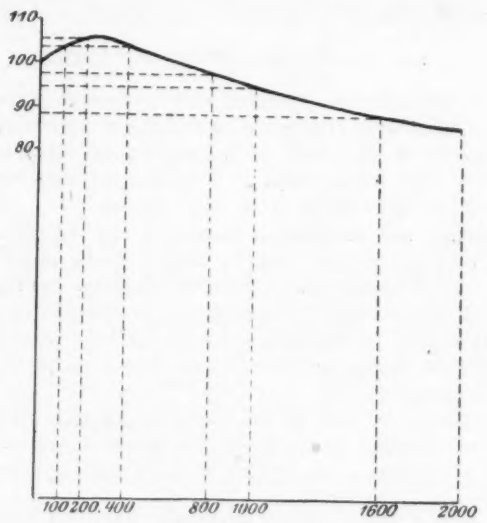


FIG. I.—LIFE CURVES OF LAMPS.

then subjected to the most important process which is called formation. The threads which now consist of porous rough osmium with a high content of carbon are heated for a long time by means of an electric current gradually to a higher and higher temperature up to white heat in an atmosphere which contains very much steam and smaller or larger quantities of reducing gases. The filament thus becomes pure porous osmium of a far greater density than the former rough thread. During the use of the lamp the osmium surface becomes gradually more and more smooth, this accounts for an increase of the light given out by a lamp during the first hours. Fig. 1 shows the variation of the light given out by a 37 to 44-volt and

25 to 32-cp lamp in per cents of the original light, the abscissæ representing hours. The filaments of these lamps which consume 1½ watts per candle-power have a diameter of about 0.087 mm. and a length of about 280 mm. On account of the increase of resistance with temperature, an increase of the voltage by 10 per cent. results in an increase of the current by 6.5 per cent., while in the carbon incandescent lamp the current is increased by 12 per cent. At the same time the light in the osmium lamp is increased by somewhat over 40 per cent., while the light from a carbon incandescent lamp is increased by 80 per cent. Variations of voltage, therefore, have a much smaller influence on the light of the osmium lamp than on that of the carbon incandescent lamp. The useful life of the osmium lamp—that is, the time in which the candle-power has decreased by 20 per cent. of the original value—is about 2,000 hours. The real life is very long. A large number of lamps have been burned for more than 5,000 hours. In some plants in which lamps were installed in October, 1902, and used on an average from 800 to 1,000 hours per year, only 10 per cent. of the lamps have since been exchanged. The osmium lamp is somewhat more fragile than the carbon incandescent lamp if exposed to hard knocks. The statistics on the transport of osmium lamps shows that about 1½ per cent. were broken. The vibrations of railroad cars, however, have no effect on the osmium lamp, which has proven very satisfactory for car lighting. The lamp is of excellent service when supplied from storage batteries, especially as a safety lamp for miners; for this purpose a two-volt lamp is used. The author then describes the switching arrangement of Ehrentraut for subdivision of voltage which was illustrated in the Digest, February 4. The former difficulties in making a 110-volt lamp of long life have now been overcome. The author exhibited 110-volt lamps of 32 candles and of 25 candles. Fig. 2 shows the change of the light given out by the

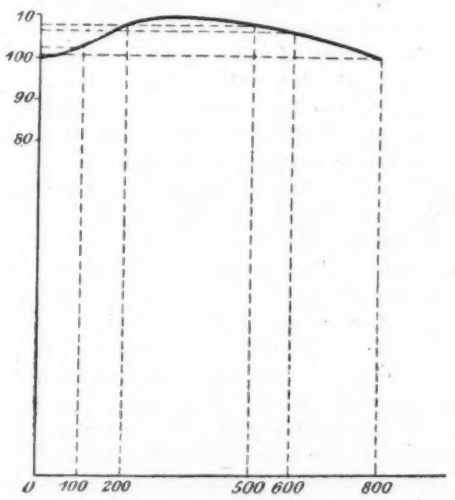


FIG. 2.—LIFE CURVES OF LAMPS.

110-volt, 32-cp lamp during the first 800 hours (the abscissæ representing hours). In the discussion Wedding expressed the opinion that neither the tantalum lamp nor the osmium lamp would soon completely replace the carbon incandescent lamp. Concerning miners' lamps, he referred to experiments which he has made as to the cost of operation of the electric lamp and of the benzene lamp, the latter being found to be the more expensive one.—*Elek. Zeit.*, February 23.

Increase of Candle-Power of Carbon Incandescent Lamps.—UPPENBORN.—With respect to the statement of Blau that the candle-power of the osmium lamp increases during the first 100 hours of burning, the author remarks that the same observation may be made with ordinary carbon incandescent lamps. He gives the following results of tests of 25 incandescent lamps in the municipal electric station of Munich:

Hours.	Candle-power.	Watts.	Watts per cp.
¼	16.3	54.0	3.296
48	17.6	55.3	3.16
144	17.95	55.4	3.08
200	16.66	55.18	3.33

This shows that even after 200 hours the candle-power had not come back to its original value.—*Zeit. f .Beleucht.*, February 20.

Alternating-Current Arc.—LEONARD.—The first part of an investigation of the variations, during one period, of the luminous flux emitted by an arc supplied with alternating current. He finds that the frequency of the variation of the total luminous flux is double the frequency of the alternating current of supply. The ratio of the total variation of the flux to the mean flux is 64 per cent., the maximum flux being in his experiments 5,050 lumens, the minimum 2,500. There seems to exist a slight phase displacement (equal to about 1/32 of the period of the supply e.m.f.) between the minimum of the total luminous flux and the zero value of the potential difference. On the other hand, there is no appreciable phase displacement between the maximum of the luminous flux and the maximum of the supply current. In analyzing the different portions of the arc he finds that the luminous flux emitted by the incandescent terminals of the carbon is sensibly constant. The flux emitted from the arc proper is rather small in the normal arc and has a frequency double that of the alternating current of supply. The luminous flux emitted by the positive crater of the lower carbon has a frequency equal to that of the current of supply. The flux emitted by the positive crater of the upper carbon has a frequency equal to the preceding one, but is displaced in phase with respect to it by half a period of the e.m.f. The luminous fluxes due to the negative craters have the same frequencies as the two preceding ones, but are displaced with respect to the older ones by half a period.—*L'Eclairage Elec.*, February 18.

Lighting of School Rooms.—STELZ.—An illustrated article giving the results of photometric tests of the lighting of school rooms with incandescent lamps. He considers as the normal requirement for good lighting that one 16-cp lamp at a height of 3.7 meters (12 ft.) above the ground is necessary per 1⅓ square meter (14.4 sq. ft.).—*Elek. Zeit.*, February 16.

Power and Lighting Equipment of a Brooklyn Museum.—WALSH.—An illustrated description of the plant of the Brooklyn Institute of Arts and Sciences on Eastern Parkway. Three engines, two of 320 hp and one of 120 hp, furnish the motive power. These are direct-connected to compound-wound, direct-current machines. The current is used almost exclusively for lighting.—*Am. Elec.*, March.

POWER.

Utilization of Tidal Power.—A discussion of the possibilities of obtaining motive power from the rise and fall of the tides. The irregularity of the motive power and the importance of the cost of installation are pointed out. Attention is called to the high efficiency of all water motors. The surplus power in spring might be utilized for electroplating and other electrochemical work; but if in practice such arrangements were found impracticable or more costly, then by the extension of the high level reservoir system the supply of power might be made constant.—From the *Engineer;* abstracted in *Eng'ing Mag.*, March.

Small Motors.—KIMBALL.—The conclusion of his fully illustrated article on the widening use of small electric motors with special reference to American practice. The author describes the use of electric motors for driving laundry machinery, candy machinery, apparatus used by physicians, etc. The application of electrically-driven machinery in printing offices, book binderies and mines is also dealt with.—*Cassier's Mag.*, March.

Steam Turbines.—MUNCH.—The first part of a discussion of steam turbines and their application in electrical engineering.—*L'Eclairage Elec.*, February 18.

Fan Motors for 1905.—The annual illustrated article on American fan motors. The present article describes only the new fans and the improvements in the old ones.—*Am. Elec.*, March.

TRACTION.

Single-Phase Traction in England.—Some notes on the electrical equipment of the suburban lines of the London, Brighton & South Coast Railway. Dawson has worked out the scheme for this equipment which will have a single overhead wire of 0.5 sq. in. in section for each line of rails, fed at about half-mile intervals with single-phase alternating current at 6,000 volts and 25 periods per second. A suspended center conductor will be employed. The rails will be bonded not to one another, but to a return conductor "which it may be presumed will have to be concentric with the feeders to the overhead line, in order to diminish impedance as much as possible." At the outset a five-mile length will be equipped, but the whole length of the road will represent 25 miles of single track. Tenderers are to assume an average speed of about 22 miles an hour with 20-second

stops at the stations and two minutes at terminals, and a unit train of two motor cars and one trailer, each seating 60 passengers, and they are to guarantee to keep within certain limits as regards the heating of the motors. There will be four motors per car, each rated at 250 hp, and connected to the axles by single reduction gear. A multiple unit of control is insisted upon, with no train cable carrying the main current from car to car.—Lond. *Elec.*, February 17.

Tramways and Omnibuses.—SAYERS.—A discussion of the question recently brought up by a London daily paper on tramways versus motor buses This paper had claimed that tramways were obsolete and the tens of millions spent upon them were wasted money, since motor buses would soon take their place. The present author shows that the working cost of a motor omnibus, including repairs, is from 23 cents to 25 cents per car mile, and its carrying capacity 34 passengers. The working ocst of an electric tramcar is from 10 to 12 cents per car mile and its carrying capacity from 50 to 70 passengers. The much greater margin between working expenses and earning power is far more than sufficient to cover the disbursements put upon the tramway owner for capital charges, track maintenance, paving maintenance and rates wherever anything approaching a frequent service is demanded. The proprietors of omnibuses pay nothing for the maintenance of the roads, while the trolley companies do. It has been claimed that the motor omnibus can give a quicker service than the tramcar, but this advantage so far as it exists in fact is purely artificial and temporary.—Lond. *Elec.*, February 17.

Conduit Railways.—A reprint of a report by Baker on the conduit lines of London and New York. He gives a table of comparison between the New York and London County Council conduit systems. The constructional costs in New York are about 50 per cent. higher than in the case of the London Council's tramways, this being probably accounted for by the facts that some portions of the conduits had to be excavated through solid rock; that an extended and more expensive form of yoke is used than in London; that all labor and materials are dearer in New York than in London; and that the pipe obstructions are greater than those met with in the reconstruction of the Council's lines.—Lond. *Elec. Rev.*, February 17.

Sliding Bow Versus Trolley.—HOOGHWINKEL.—A brief communication in favor of the sliding bow which the writer considers as being especially adapted for use in England on account of the much lighter overhead network in densely populated towns.—Lond. *Elec.*, February 17.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Preventing Excessive Pressure Rises.—A description of two new safety devices for preventing excessive pressure rises in alternating-current systems, according to recent British patent specifications. The first is a method of the Lahmeyer Company. When machines are switched in or out disruptive discharges may easily occur and this principally happens in the coils or parts of conductors which are nearest to the current-supplying mains. To remove this dangerous pressure from the machine, the first coil which shows the largest increase of voltage is connected in series with a choking coil which chokes under normal working conditions the same amount of voltage

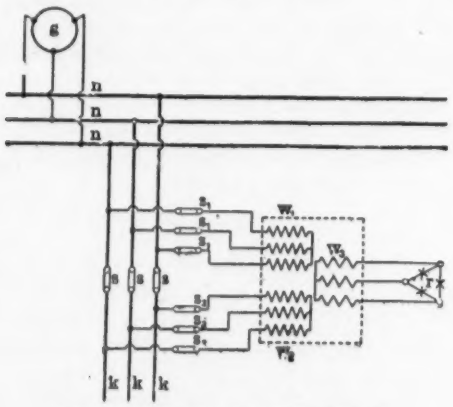


FIG. 3.—DIAGRAM OF CONNECTIONS.

as every armature coil. This action of the self-induction can be explained as follows: When the self-induction is not switched in, the coils, or parts of conductors nearest to the supply main, exert a choking action when the current is turned on, so that the whole amount of excessive pressure is, so to speak, concentrated in these first portions of the coils. If, however, self-induction be switched in series with the machine, this self-induction takes up the excess of voltage. The self-induction coil can easily be so insulated that a disruptive discharge cannot occur therein. The choking coil may be short-circuited by another movement of the switch after the starting has been effected. A single choking coil may be used for several machines, this single choking coil being switched in only when a machine is switched in or out. The second method has been devised by Siemens Brothers & Co., and is shown in Fig. 3. g represents a three-phase current generator, and n are the network conductors, from which the cables, k, are branched by means of the switches, s. The auxiliary appliance consists of a transformer with three windings, of which w_1 and w_2 have the same number of turns, and are connected in the same direction by means of switches, s_1 s_2, respectively, before and after the main switches, s, to the cables, k. The third winding, w_3, of the transformer, on the other hand, which is advantageously arranged for low pressures, is connected to a non-inductive loading resistance, r, of suitable value. Assuming, in the first instance, that the winding, w_3, is open, but that all the switches are closed, then only the magnetizing current of the transformer will flow in the equal windings, w_1 w_2. As regards the conditions of magnetization, nothing will be altered if the winding, w_3, be connected up with the resistance, r. Practically the same pressure of the connecting points, w_1 w_2, will still be maintained if the switches, s (which are to be considered as combined to form a three-pole switch) are opened; in consequence, no sparks can be formed at the switches, and no oscillations can be produced in the cables. In the same way dangerous oscillations in the cables will be prevented, if the switches, s_1, now be opened, because there are produced at these switches sparks, the extent of which depend upon the resistance, r. Such sparks, as is known, allow of no rapid oscillations, in contradistinction to the charging sparks produced on the switching in of unloaded cables. The loading resistance, therefore, acts as a damper of oscillations. The arrangement, which can, of course, be applied to networks having any number of phases, will be as follows: If the unloaded cables, k, are to be separated from the network, n, then, in the first instance, the switches, s_1 s_2 of the auxiliary are closed, one after the other; the switches, s, are then opened and the direct connection between the cables, k, and the network conductors, n, thereby broken; the switches, s_1, are then opened whereby the cables, k, are deprived of their pressure and by finally opening the switches, s_2, the cables are separated from the auxiliary appliance. When connecting unloaded cables, k, to the network, n, the switches have to be manipulated in the reverse order, by first closing s_2 then s_1, and by finally closing s. When the cables are connected to the mains direct, the switches, s_1 and s_2, are opened one after the other and the auxiliary appliance thereby disconnected. The auxiliary appliance, described above, is also very suitable for testing cables under pressure. In this case the main switches, s, would be open or entirely dispensed with. If a higher pressure than that of the existing network pressure is to be used for the testing, then the translation ratio of the windings, w_1 and w_2, instead of being 1 to 1, is made to correspond with the intended testing pressure.—Lond. *Elec.*, February 17.

Rheostat.—An illustrated description of details of construction of a new motor rheostat made by a British company.—Lond. *Elec.*, February 10.

German Central Station Statistics.—In the abstract on page 256 of the Digest in our issue of February 4, the first and third tables refer to whole Germany, while the second table—which was given as an illustration of the enormous increase of the electric current for power purposes in recent years—gives the figures for the Berlin Electricity Works only.

WIRES, WIRING AND CONDUITS.

Overhead Transmission Lines.—SEMENZA.—A paper read before the Italian Electrical Society. He deals especially with the construction of the poles. The most suitable span is the one which requires the smallest weight of material per mile, and it can be only ascertained by successive approximations. Long spans, besides improving the line electrically, require less expense for way leaves. The author recommends iron posts and describes what he considers a very great improvement in the construction of metallic supports, consisting in making them elastic. In a straight track, and with equal spans, the only force acting on the supports, apart from the weight of the wire, is the transverse wind pressure. It is, therefore, un-

necessary to make them withstand a longitudinal stress, and they need only be designed for a transverse stress. As is seen from Fig. 4, they consist of two parallel uprights of channel iron about 2 meters apart trussed together with angle irons. Should the wires

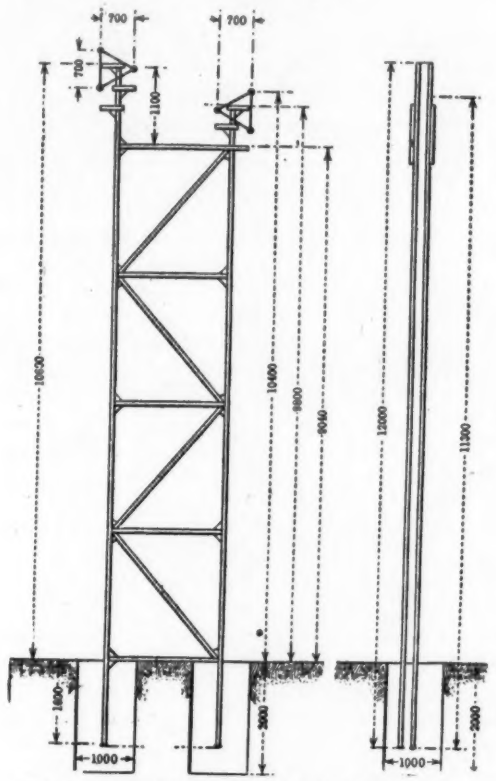


FIG. 4.—STRUCTURE FOR TRANSMISSION LINES.

ever get broken, the supports by their elasticity will bend in the longitudinal direction, and this deflection will instantly diminish the tension. In the highly improbable case of the breakage of all the wires in one span, it is found that the first support beyond the break will deflect considerably, but as this deflection diminishes the length of each successive span, and, therefore, the tension of the wires, the second support will be deflected, but to a less extent. The farther supports will also deflect, but will always to a lesser degree, and by calculation it is found that should the tension be entirely removed from one side the resulting stress would not exceed half that on a rigid support. Thus he arrives at "the apparent paradox that the weakness of the support is a factor of its resistance to breaking." The author urges the great importance of the choice of proper insulators.—Lond. *Elec.*, February 17.

Earthing the Neutral Wire.—MÜLLENDORFF.—A discussion of the question whether the neutral wire of a direct-current, three-wire system should be earthed as required by the regulations of the German Association of Electrical Engineers. The author arrives at the conclusion that in general it is preferable not to earth the neutral wire, but to insulate it just as well as the outers. In regulations the earthing should be permitted, but not required.—*Elek. Anz.*, February 15.

Heating of Cables.—TEICHMÜLLER.—A long mathematical communication in reply to some critical remarks of Kath on formulas for calculating the heat developed in cables.—*Elek. Zeit.*, February 23.

ELECTROPHYSICS AND MAGNETISM.

Electromagnetic Waves in the Visible Spectrum.—BRAUN.—Many attempts have been made to identify these waves with light waves. Braun forms suitable resonators or "gitters" by deflagrating very fine wires stretched on glass plates; and then observing changes of polarization by means of suitable optical devices directed upon the particles of finely divided metal. According to the electromagnetic theory, these "gitters" should allow little light through if the arrangements of the particles are parallel to the electric vector, and much if they are perpendicular to it. The author believes that his photographs show a complete analogy between Hertz waves and optical waves. He shows also that the method he employed is of importance in mineralogical work.—*Am. Jour. of Science,* March; from *Ann. der Phys.,* No. 1, 1905, p. 1.

New Type of Atmospheric Ions.—LANGEVIN.—An account of the discovery of a type of slow-moving ions whose existence in the atmosphere has hitherto been unsuspected. He used Ebert's method of conducting air through a cylindrical condenser and measuring the currents passing through the condenser with various e.m.f's and various velocities of the blast. He obtained only two different mobilities. One was the well-known mobility amounting to 1.5 cm. for a gradient of 1 volt per centimeter. The other mobility was 4,000 or 5,000 times less than this, and corresponds to that found by Townsend in freshly-prepared gases, or that found by Bloch for the ions of phosphorus. Ebert's instrument as usually constructed fails to indicate these ions, which, however, may convey 50 times more electricity than the usual ones.—Lond. *Elec.*, February 17; from *Comptes Rendus,* January 23.

Zeeman Effect.—ZEEMAN AND GEEST.—If light traverses very attenuated sodium vapor placed in a magnetic field in a direction normal to this field there is double refraction according to Voigt's theory. The present authors have made experiments which confirm Voigt's theory extremely well.—From *Proc. Royal Academy* of Amsterdam, December 24, 1904; abstracted in Lond. *Elec.*, February 17.

Electric Inertia.—BURBURY.—A highly mathematical paper on the theory of electric inertia, carrying further the investigations of Lodge. —*Phil. Mag.*, February.

ELECTROCHEMISTRY AND BATTERIES.

Lead Accumulator.—A note on a new lead acumulator called "E. I. T." Both plates are pasted and it is claimed that the novelty rests in the use of special lead oxides. The useful average e.m.f. is stated to be 5 per cent. higher than that of the ordinary lead accumulators for the same quantity of active material and the capacity is said to be 33 to 50 per cent. higher than in accumulators in which the ordinary pastes are used. According to tests made in Paris the battery has an energy per weight of 41.2 watt-hours per kilogram with an initial e.m.f. of 2.29 volts and an initial useful potential difference of 2.07 volts, the discharge being continued down to 1.7 volt at an average rate of 5.5 watts per kilogram. The density was 1.32 (35° Baume) at the beginning of the discharge and 1.16 (20° Baume) at the end. This unusually high density of the electrolyte might explain the result of the tests and it is very doubtful whether an accumulator with such concentrated acid has any long life.—*L'Industrie Elec.*, February 10.

Metallurgical Calculations.—RICHARDS.—The first part of a serial on metallurgical calculations. The author emphasizes that the making of calculations concerning the quantitative working of any process, furnace or piece of apparatus used in metalllurgical operations is of the greatest importance for estimating the real efficiency of the process, for determining avenues of waste and possible lines of improvement, and for obtaining the best possible comprehension of the real principles of operation involved. He gives the outline of the subjects to be dealt with in the serial and then discusses in the first installment the significance of chemical equations and the information which they give concerning the weights involved in reactions and concerning the volumes of gases developed. He shows how to apply corrections for temperature and pressure and gives problems illustrating the principles discussed. These problems relate to the combustion of commercial fuels and to Bessemer converter practice.—*Electrochem. and Met. Ind.*, March.

Electric Furnace in the Iron and Steel Industries.—ALLEN.—Some calculations with reference to the thermochemistry of iron ore reduction and steel making in the electric furnace. The author concludes that "a study of the thermo-chemistry of the production of iron and steel by means of the electric current shows that when carried out on a system as nearly as possible in accordance with that required by theory, the capabilities of profitable application only require scientific treatment to prevent an excessive charge for electric current from turning the scale between profit and loss, even in the field of the blast furnace."—*Cassier's Mag.*, March.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Weston Instruments for Ballistic Magnetic Testing.—GANZ.—A paper presented before the Physical Section of the American Association for the Advancement of Science. It has formerly been claimed that a damped galvanometer in which the damping force is proportional to the velocity of the moving system may be used for ballistic magnetic testing. Stewart has also claimed that a Weston ammeter without its shunt or a Weston voltameter without its series

resisance may be used for determining permeability and hysteresis curves by the ballistic method. The present author gives an account of experiments made by Greve and Barkus in order to compare the permeability and hysteresis curves obtained by means of ordinary Weston instruments, with the curves obtained by means of a slow-period undamped ballistic galvanometer. It was found that the curves for a laminated iron ring obtained with an ordinary Weston instrument fell about 3 per cent. below the curve obtained with the ballistic galvanometer. It was also found that the preliminary curve for a solid iron ring (cross-section 1 sq. in., mean diameter 7 in.) obtained with an ordinary Weston instrument, fell over 10 per cent. below the curve obtained with the ballistic galvanometer. The cause of this falling below is undoubtedly that the time of the first swing of the ordinary Weston instrument is too short to take account of all the change in the magnetic flux which occurs. The Weston Instrument Company then constructed a special instrument having a greater moment of inertia and more magnetic damping than their ordinary instruments, and having, therefore, also a much longer time for its first swing. This new instrument was found to give a permeability curve for the laminated ring which agreed exactly with the curve obtained with the ballistic galvanometer. For the solid ring the permeability curve was still, however, several per cent. below the curve obtained with the ballistic galvanometer. In order to make a direct-reading magnetic flux meter out of this instrument 30 ft. of flexible cord were used for a secondary coil, and a resistance was added to the instrument, and this was adjusted so that the instrument would indicate change of flux in kilomaxwells per turn using this secondary. This instrument was, therefore, called a "Weston maxwell meter." This maxwell meter has been considerably used in the laboratory of Stevens Institute for obtaining magnetization curves, measuring leakage coefficients, etc., and has been found extremely useful. The Weston Company is now constructing a second special instrument having a still slower period, which is expected to give accurate results as well for solid iron samples as for laminated ones, and this will be a direct-reading portable and permanent maxwell meter having a uniform scale, which will be generally useful for all kinds of magnetic testing and which can be used directly without previous calibration. Owing to the slow period of these special instruments the extent of their first throws can be very accurately noted.—*Science,* March 3.

Electricity Meters.—GERHARDI.—A continuation of his illustrated serial. In the present installment he describes Thomson meters and the Westinghouse integrating wattmeter.—Lond. *Elec.,* February 24.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephony in Great Britain.—A long account of the agreement which has been entered into between the English Postmaster-General and the National Telephone Company, subject to the ratification by the House of Commons. The license under which the National Telephone Company is working expires with the end of 1911, and arrangements have now been made for a purchase of the plant by the post office at mutually favorable terms. The case is somewhat complicated by the existence of "competitive" telephone areas of which the most important is London. By an agreement the two systems of the Post Office and of the company are being worked rather in partnership than in competition, evidently with a view to the gradual establishment of one complete system which will fulfill all the requirements of telephony in London by the time the transfer is to take place.—Lond. *Elec.,* February 24.

Electrolytic Rectifier in Telephone Stations.—STOSBERG.—A description of the use of an electrolytic rectifier for changing three-phase current into direct current for telephonic purposes, the well-known rectifying effect of the aluminum electrode being made use of. —*Elek. Zeit.,* February 23.

Telephone Sub-Station and Its Connection to the Central Office.—O'BRIEN.—An illustrated article treating of the arrangement of sub-station lines which radiate from the central office and the equipment which is necessary at the sub-station.—*Am. Elec.,* March.

MISCELLANEOUS.

Machine-Made Line Drawings for the Illustration of Scientific Papers.—DALY.—The Geological Survey Department of Canada uses a typewriter provided with a carbon ribbon and with 90 special characters designed for the preparation of line drawings to accompany geological and geographical papers. The same machine can be similarly used for statistical, engineering and other diagrams. In the preparation of the diagram an outline drawing is first prepared and the spaces thus formed are filled with the symbols shown in the legend, by means of the machine.—*Am. Jour. Science,* March.

Cost of Manufacture.—GUNDEL.—A paper read before the Karlsruhe Electrical Society. The author gives statistical data showing how the selling price of electrical machines has decreased in recent years. The consumption of material (copper, iron) for a machine of given power has correspondingly decreased, but the expense for wages has not been diminished in a similar degree, so that there is now less profit in manufacturing electrical machines than formerly. The author discusses at great length various methods of paying wages, and especially the premium systems of Halsey and Rowan, which are now being introduced in Europe.—*Elek. Zeit.,* February 16.

New Railway Power House at Port Clinton, O.

The Toledo Interurban Construction Company has recently awarded to the Allis-Chalmers Company the contract for the complete equipment of the new power house of the Toledo, Port Clinton & Lake Side Railway at Port Clinton, O., including two 1,280-hp Reynolds-Corliss engines, two 800-kw Bullock alternating current generators, two 50-kw Bullock direct current generators, one 400-kw Bullock alternating-current rotary converter, two Tomlinson barometric condensers and boilers, pumps, heaters, etc. The contract calls for the completion of the plant in every detail by or before July 1, and is noteworthy from the fact that of the very varied equipment to be furnished the greater portion will be constructed in the manufactories of the successful bidders. Bullock railway motors have been in successful operation on this road for some time past.

Arrangements have been made to have the new extension of the railway completed as far as Marblehead, and cars put in operation to that place from Toledo by the date specified. It is planned to run cars the entire length of the line—from Toledo to Lakeside—in two hours.

Power for that portion of the road already in operation is being taken at present from a rotary converter used as a generator in the temporary power plant at Genoa; but the better facilities which will be afforded for distributing power equally over the entire system, and other conditions, make Port Clinton a more desirable point, and upon completion of the plant there, the one at Genoa will be used only as a sub-station. Another sub-station is temporarily located below Oak Harbor. The company uses the three-phrase system for distribution.

Crocker-Wheeler 4000-KW. Alternators for Chicago Sanitary District.

An order for four 4,000-kw, three-phase, 60-cycle, 6,600-volt, alternating-current generators, with exciters, has just been placed with the Crocker-Wheeler Company, Ampere, N. J., by the trustees of the Sanitary District of Chicago. These are to be driven by Wellman-Seaver-Morgan horizontal water wheels and put in operation at Lockport, Ill., the western end of the Chicago Sanitary and Ship Canal.

It was less than a year ago that the Crocker-Wheeler Company, long established in the field of direct-current manufacture, began to market a line of alternating-current generators for operation with every description of prime-mover. It will be recalled that the California Gas & Electric Corporation recently placed an order for three 4,000-kw Crocker-Wheeler alternating-current generators, to be driven by gas engines, which will supply current for all the street railways in San Francisco. This order and the present one, with the many other alternating-current orders which the company has filled, place the company securely in the front rank of manufacturers in this particular field.

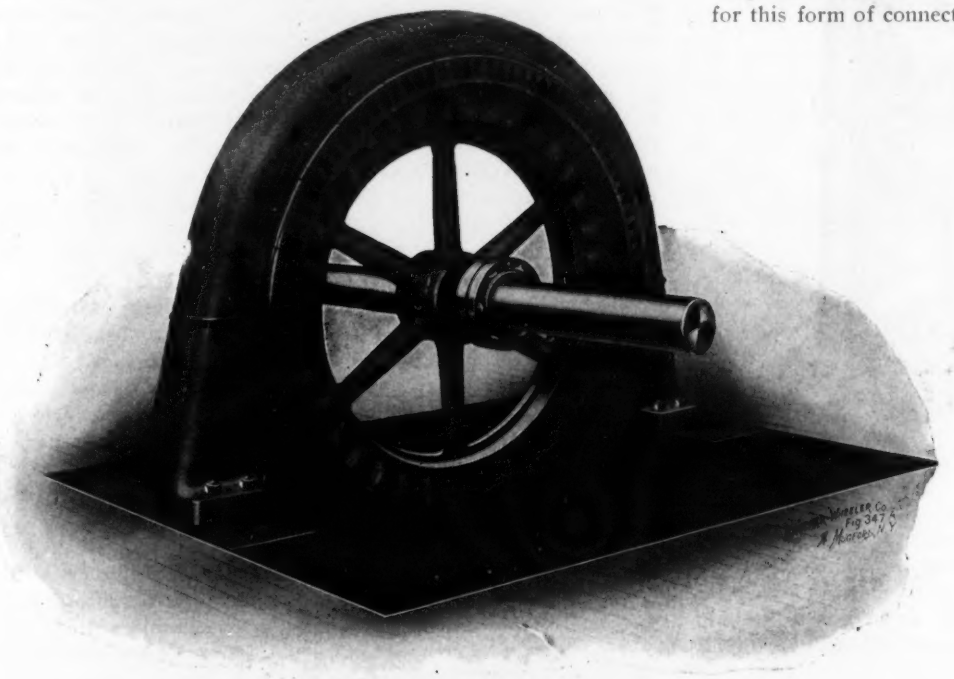
The type of machine ordered is shown in the accompanying illustration. The two exciters for these machines will also be water-wheel driven and of 350-kw capacity each at 300 r.p.m.

Six years ago the Chicago Sanitary and Ship Canal, which is more than 28 miles long, and designed primarily to convey the sewage of Chicago to the Desplaines and Illinois Rivers and so to the Mississippi, was opened and filled with water from Lake Michigan. Since then it has been performing its sanitary function.

Since June, 1893, Mr. Isham Randolph, formerly president of the Western Engineering Association, has had in hand this great project of tapping the Great Lakes at their southern end. His present work

is centered at Lockport, where the mean head for water power development, when the present improvements are completed, will be 32 ft. and the net power 40,000 hp. The ultimate discharge of the canal will be 800,000 cu. ft. per minute. A structure of concrete and brick construction will house the power, and provision will be made for eight generator units, four of which are now under contract. The power generated at Lockport will be used for municipal lighting in Chicago.

The third great use of the canal, as a section of a deep waterway connecting Lake Michigan and the Mississippi, is yet to be realized. The City of Chicago will have spent $55,000,000 on this canal. If the canal had been built for sanitation alone the cost would have been $18,000,000 less. Whether or not the Federal Government takes up this work and completes this link between the Great Lakes and the Gulf of Mexico, the Chicago Sanitary and Ship Canal may well be called "the greatest artificial waterway ever constructed."



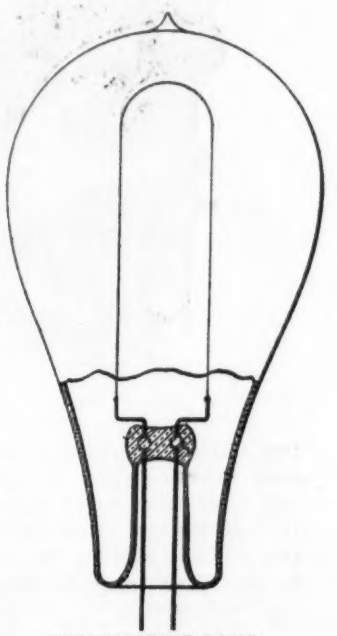
REVOLVING FIELD ENGINE TYPE ALTERNATOR.

All-Copper Incandescent Lamp Leading-in Conductor.

As is well known, one of the large items of expense in the manufacture of incandescent lamps under present methods, is for the platinum connection between the filament and the leading-in wires. Though the amount of platinum used for this purpose is now very much less than formerly, on the other hand the price of platinum has very greatly advanced, the market value at present being considerably higher than for gold. In addition to the cost of the material itself, is the additional expense of fusing the platinum at one end with the leading-in wire and at the other end with the conductor on which the filament is mounted, and the labor attending cutting the platinum wire into suitable lengths. The reason given for using platinum is that its coefficient of expansion is about the same as glass, and consequently when contracting and expanding there is no tendency to open the joint between the metal and the glass, thus excluding air leakage. Inventors have sought an alloy which would replace the platinum, and while several alloys appeared to possess the desired property, for one reason or other none has entered into commercial use.

A recent patent granted to Mr. John H. Guest, of Brooklyn, N. Y., whose name is well known in connection with electrical invention in other lines, offers a solution to this problem. Referring to the accompanying illustration, it will be seen that a single conductor is used, one end serving as the filament terminal and the other for connection to the lamp base. As will be noted, that part of the leading-in wire which is sealed in the glass is stamped in such a manner as to introduce a ring into its length, the walls of which are highly attenuated and integral with the straight parts of the conductor. Since copper has about six times the conductivity of platinum, it follows that the part of the conductor which constitutes the ring can be made of much smaller cross-section than a platinum wire, and the cross-section of each side of the ring is reduced much more than half that of the wire itself, thus minimizing the strain at heating and cooling.

It is claimed that owing to the circular form given to the sealed-in portion, any strain due to expansion or contraction is not transferred to the integral straight portions of the conductor on either side. We are informed by the inventor that he has had a number of lamps made employing this connection, the first of these were made last October and were exhibited in the United States Patent Office at Washington, and are still in good condition, though some of the lamps have burned over 700 hours. An advantage is also claimed for this form of connection with respect to high candle-power lamps, in which case two or more pairs of the connections may be easily sealed into the glass; as there are two paths for the current in the ring part of the conductor, and the conductivity being so much greater than that of platinum, it follows that the same conductor used for a 16-cp lamp may be used for a 32-cp lamp.



INCANDESCENT LAMP.

As the expense of the material scarcely enters, and the manufacture involves a minimum of manipulation, the cost of this connection is stated to be but a mere fraction of the cost of the usual connection employing platinum.

Controlling Apparatus for Motor-Driven Machine Tools.

In designing controlling apparatus for motor-driven machine tools the Ward Leonard Electric Company has made a special study of all the requirements of this special motor service.

As regards motor starters, these requirements may be enumerated as follows:

The motor starter must be enclosed, rust proof and dust proof, doing away with any possibilty of short circuits due to the flying of chips, etc.

To prevent arcing upon the first live contact, there should be provided some auxiliary making and breaking device. The machinists who start and control motor-driven machine tools are very apt to move the starting arm up to the first live button, then draw it away, drawing an arc; therefore some precaution should be taken to prevent the destruction of the starter.

It is necessary that the automatic "no-voltage" release should be responsive solely to the line voltage and should be entirely independent of the field and armature currents. There are many different types of motors used—series, shunt, compound and variable speed types, etc. The field resistance and the amperes flowing through the field vary greatly in each case. It is almost necessary that starters should be interchangeable. For instance, a 3-hp, 110-

volt motor starter should be applicable for use with a series, shunt, compound, separately excited or variable speed motor, and such a starter cannot be built commercially unless the no-voltage release magnet is connected across the armature terminals or across the line and made independent of the field and armature currents.

Unquestionably the greatest chance for overloads in motor-driven machine tools is during the period of starting, when the machine

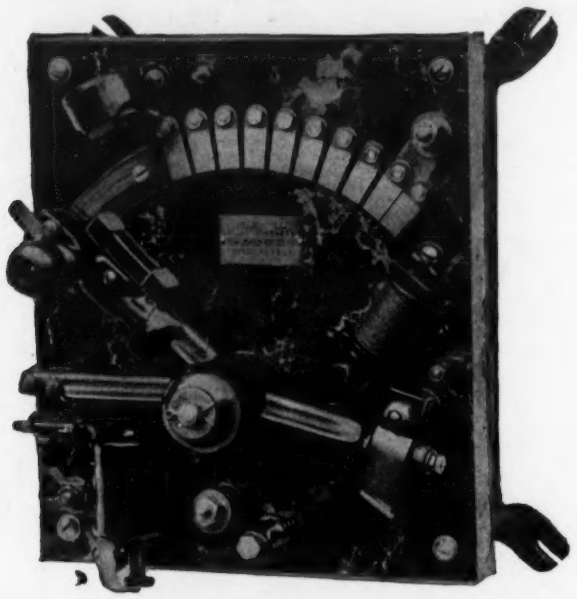


FIG. 1.—MOTOR STARTER.

tool and the motor have been repaired or altered, and conditions have been changed. An overload device is necessary, therefore, which will protect the motor at the instant of closing the circuit through the motor, during the period of starting or as long as the operator has hold of the controlling lever, as well as at all other times. This circuit breaker is the old-time machinist's "slipping belt" safeguard.

It is essential that motor starters be kept as small and compact as possible. All parts should be strong and all parts should be removable and renewable.

The above requirements have been carefully worked out in the Ward Leonard types of motor-starters and of motor speed-controllers, one type of which is shown in Fig. 1.

If variable speed motors are used, that is, a motor whose speed changes are obtained by varying the field strength, then there are two possibilities:

First, a motor-starter as described above, which might be mounted upon the wall, and a field rheostat equipped with a no-voltage release protective device, mounted upon the machine tool. Second, a combined motor-starter and field regulator. In each case it is absolutely necessary to equip the controlling apparatus so that it is impossible to start the motor under conditions of weakened field. The Ward Leonard type of combined armature and field controller with automatic features, represents this second type, as shown in Fig. 2, the rheostat being mounted on the left-hand side.

If a starter is used mounted upon the side wall and the field rheostat is mounted upon the machine controlled (as per first type), then the field rheostat must be equipped with a no-voltage release protective device which can be briefly described as follows:

An ordinary motor starter may be mounted upon the wall anywhere near the machine. The field rheostat, which is the speed controller, may be mounted directly upon the motor or machine driven. Upon opening the line switch to stop the motor, the field rheostat no-voltage magnet is de-energized, its armature is released and it falls and short circuits the resistance of the motor field rheostat. Upon restarting, the motor is necessarily started with its full field strength. By moving the field rheostat lever to the "no resistance in" position, the armature of the "no-voltage" release magnet is raised, the short circuit around the field rheostat is removed and the resistance of the field rheostat can then be cut in circuit to obtain the speed changes desired. The Ward Leonard Company claims that its apparatus of this type is the first field rheostat which has ever been put upon the market equipped with a no-voltage release protective device, for the purpose under discussion. One of this type is shown in Fig. 3.

The requirements of a field rheostat for variable speed motors for speed variation as high as 2 to 1, 3 to 1 and 4 to 1, are such that in the past special regulators had to be constructed for each case. The Ward Leonard standard motor field rheostats have as a maximum resistance 2,900 ohms, with an ampere capacity tapered from .5 to .06, and are of three types namely, those with a 4-to-1 taper in ampere capacity, those with a 6-to-1 taper in ampere capacity, and those with an 8-to-1 taper in ampere capacity, which are used, respectively, for a 2 to 1, 3 to 1, and 4 to 1 variations in speed.

If a starter is designed properly with renewable segments, skate shoe contacts and an overload device which is a circuit breaker (which takes the arc at points designed for that purpose), and is provided with auxiliary quick making and auxiliary quick breaking device, then it is good engineering, and it is easily possible to enclose the face of the starter as shown in Fig. 4. This type of controller is built to replace all drum types, up to and including 10-hp, 110-volt size. The face plate is protected from flying chips, etc., and it is the only type of absolutely fire-proof starter with which we are familiar.

For machine tool work, there is a large demand for reversing regulators and reversing starters with field control. The Ward Leonard type, shown in Fig. 5, has an armature controlling resistance divided into 15 steps in each direction, with ohms sufficient to reduce the motor speed to one-half of full speed even with only one-quarter load, and to operate the motor from dead rest to full speed at any load from one-half load to full load. The field resistance is divided into 25 steps, giving very gradual changes in speed. The controller is suitably arranged to be equipped with a sprocket wheel or bevel

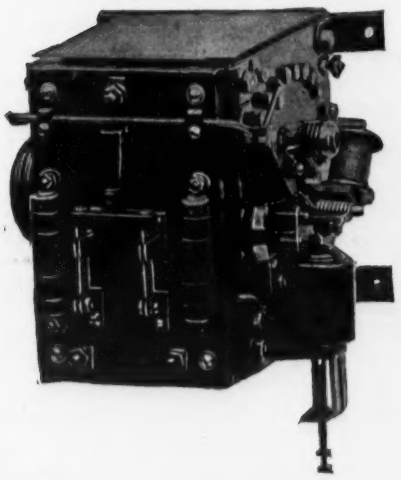


FIG. 2.—COMBINED MOTOR-STARTER AND FIELD REGULATOR.

FIG. 3.—FIELD RHEOSTAT WITH PROTECTIVE "NO-VOLTAGE" RELEASE.

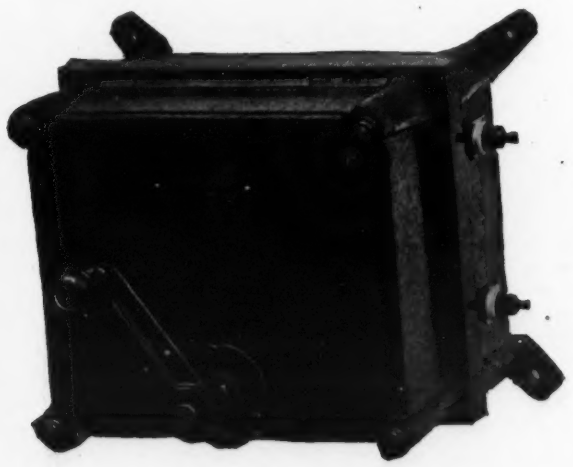


FIG. 4.—ENCLOSED STARTER.

gears, as desired. The rheostat is built up of Ward Leonard enameled resistance tubes, and is a reversing controller having both

FIG. 5.—REVERSING REGULATOR AND REVERSING STARTER WITH FIELD CONTROL.

armature and field control. In connection with it is used an overload and no-voltage circuit breaker having the important feature that it cannot be held closed upon overload or short circuit.

Diehl Motors.

One of the companies which first took up the development of the fan motor was the Diehl Manufacturing Company, of Elizabethport, N. J., and its work in bringing this type from the crude apparatus of ten or twelve years ago to its present highly efficient state is a matter of industrial history. Recently the company has entered the general motor field, and in the larger size motors will bestow the same attention to all of the niceties of design which have characterized its work in the more restricted field. Its first line of motors comprises two types, one of which is built in capacities from ½ to 2 hp, and the other in capacities from 3 to 25 hp. The motors are adapted for special as well as for general power purposes, and in the design particular attention has been paid to the minute details of construction, as well as high efficiency, low heat limit and sparkless operation at all loads up to 25 per cent. overload without change in position of the brushes.

In sizes from 3 hp up the frames have steel yokes of high mag-

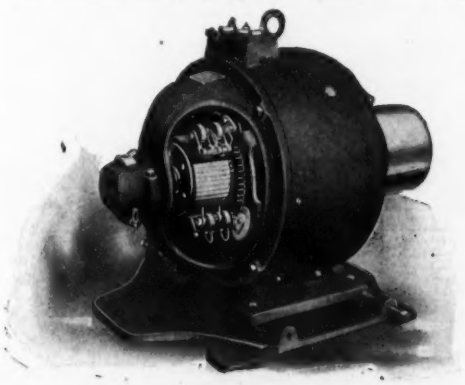


FIG. 1.—MOTOR.

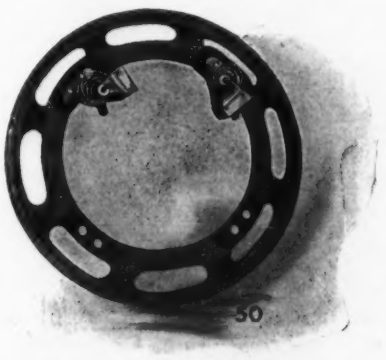


FIG. 2.—ROCKING RING.

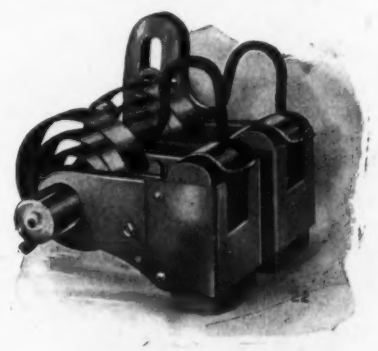


FIG. 3.—BRUSH HOLDER.

netic quality with separate steel poles, having cast-iron pole pieces. The pole pieces are of such a form as careful experiment has demonstrated will give the best distribution of the magnetic flux, and particularly a wide neutral which insures sparkless operation over a wide range of load. The end covers are of three types to give, respectively, semi-enclosed, enclosed with screens and entirely enclosed motors. The enclosed motors with screens have the openings covered with a fine wire screen, the mesh of which is small enough to protect the motor from small particles of matter flying through the air. The entirely enclosed motor is air tight, and is for use where extreme moisture or injurious vapors would damage the motor.

A rocking ring replaces the old style rocker arm, thus giving a much neater appearance to the motor while adding rigidity to the

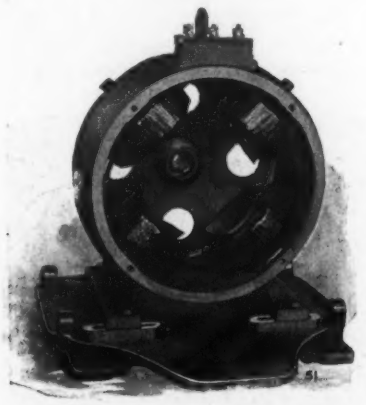


FIG. 4.—FIELD OF MOTOR.

brush-holders and giving easy access to the commutator for cleaning. The armature core is of the laminated, annealed slotted drum type, in the larger size being provided with ventilating ducts for

FIG. 5.—FIELD COIL.

circulation of air through the core. The armature coils are machine wound. The bars and mica of the commutator are assembled in a separate ring, and after being heated and compressed to the greatest

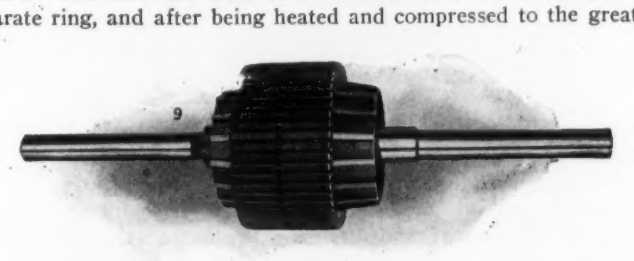


FIG. 6.—ARMATURE

possible degree, all surfaces are bored and turned. The ring is not removed until the bushing is in place and finally tightened, thus insuring a tight commutator and one in which there can be no loose bars. The field coils are form wound, heated to drive out all moisture, then dipped in insulating varnish and baked, after which they are insulated and taped. The brush-holders are of the box type and are simple and easy of adjustment. The carbon brushes can be readily removed while the machine is running. All motors are submitted to a severe test in a well-organized testing department, while all material entering into motors is tested from time to time to insure uniformity. A final breakdown test of insulation is made with alternating current of not less than 1,000 volts.

Controller for Motor-Driven Tools.

A type of controller which has been designed with especial reference to use with machine tools is illustrated in the accompanying cuts. It consists of a reversible starting device, a regulator for inserting resistance in the shunt field circuit of the motor, and a single-pole circuit-breaker connected in the main circuit. The controller is provided with sufficient starting resistance to permit of reversing

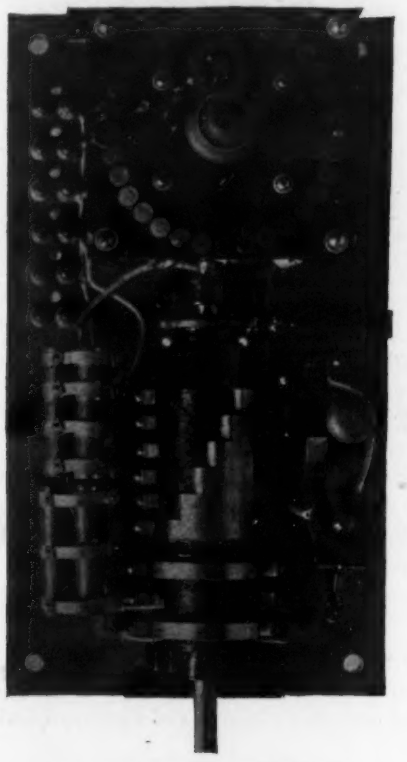


FIG. 1.—REVERSIBLE CONTROLLER.

the motor rapidly, even under weakened field, without serious arcing at the commutator.

The resistance used in the controlling panel is composed of graphite and metal of the "Globe" type, being non-corrosive and practically indestructible by heat or moisture. By the use of this resistance extreme simplicity and durability is obtained in the construction. The resistance is mounted directly upon the slate panel, no insulating material subject to deterioration, such as sand or asbestos, being used. This controller, which is manufactured by the Globe Electric Controller Company, of Amsterdam, N. Y., is shown in Fig. 2 completely enclosed by a sheet metal case, in connection with a motor of the "Storey" type, attached to a 24-in. Putnam lathe.

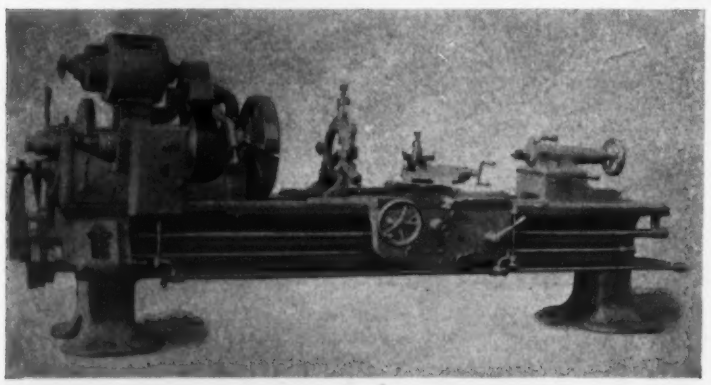


FIG. 2.—MOTOR-DRIVEN LATHE EQUIPMENT.

The Storey motor is of the enclosed type, of cylindrical form, being extremely compact and capable of being easily applied to the lathe. The design of the motor is such as to allow of a 3 to 1 variation in speed through field control alone. This variation is accomplished without seriously affecting the efficiency of the motor or causing any sparking at the commutator, even when the motor is fully loaded.

The lathe shown is adapted for screw cutting and similar classes of work, its range of speed being from 3 to 480 r.p.m. Upon the apron of the lathe is placed a lever for operating the controller to which it is connected by means of a shaft and bevel gears. The motor is at all times under perfect control, the controlling levers being within easy reach of the workman.

"Commercial" Variable-Speed Motor System.

The variable-speed motor system of the Commercial Electric Company, Indianapolis, Ind., is designed for the operation of machine tools, such as lathes and boring mills which require a wide variation in speed and an increase of the torque, or pulling power at the slowest speeds for the purpose of taking heavy cuts on pieces of large diameter. It has been designed to overcome the objections urged against the electric motors for machine driving that the capacity of the motor is decreased when the speed is decreased; that the speed is not constant under varying load when the controller is set at a certain definite point; that a portion of the power which should be utilized in operating the tool is consumed wastefully in

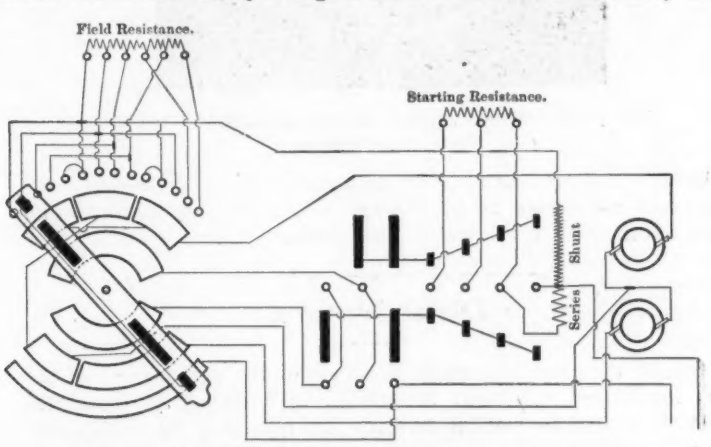


FIG. 1.—"COMMERCIAL" VARIABLE-SPEED MOTOR SYSTEM.

resistance for the purpose of speed reduction; and that a multiplicity of wires and a complicated generating and controlling system is required to avoid one or more of the above objections.

With the "Commercial" system, a standard two-wire distribution system from a standard generating plant is utilized. The capacity of the motor in brake horse-power delivered is the same at all speeds; the torque or pull is increased at the slow speed and is weakened at the high speed in proportion to the change of speed, thus maintaining the horse-power constant. The speed of the motor, when set at a given point on the controller is practically constant, whether the tool is running idle or taking the heaviest cuts possible. The controlling device is simple. The change can be quickly made and a wide range of speed is secured.

The system by which this is accomplished comprises a double commutator motor, having two windings with a different number of turns, but each winding of the same size of wire and of the same ampere capacity; a speed controller for making the necessary com-

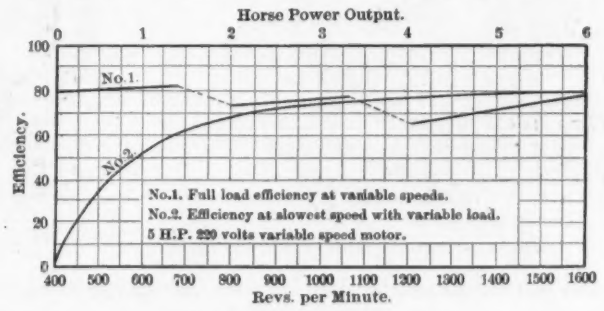


FIG. 2.—EFFICIENCY CURVES.

binations of these armature windings and for varying the field strengths to secure intermediate steps between the armature combinations; a rotary starting and reversing switch, by means of which the motor is started, stopped and reversed when the speed controller is set at any desired point. The speed controller and starting switch are combined into one piece of apparatus and enclosed in a neat, compact case, which can be placed at any desired point on the driven tool.

Speed variations are secured by different combinations of the armature windings and by varying the motor field. Three fundamental speeds are secured by the different grouping of the armature winding. The slowest speeds are secured by connecting the two

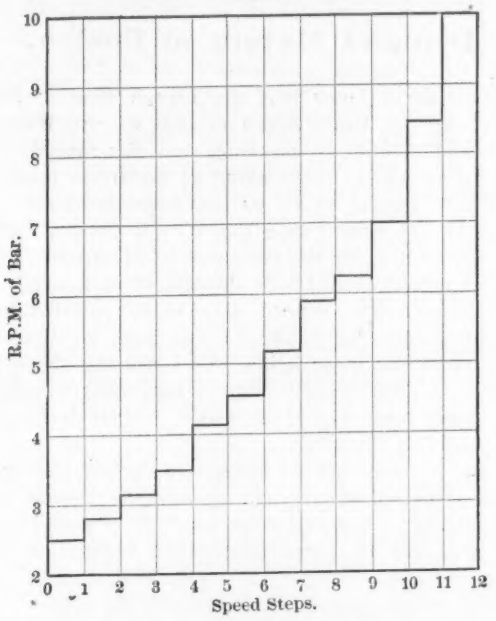


FIG. 3.—DIAGRAM OF SPEED CHANGES.

windings in series accumulatively. The second speed, which is about 67 per cent. higher than the first, is secured by operating independently one armature winding having the greatest number of turns.

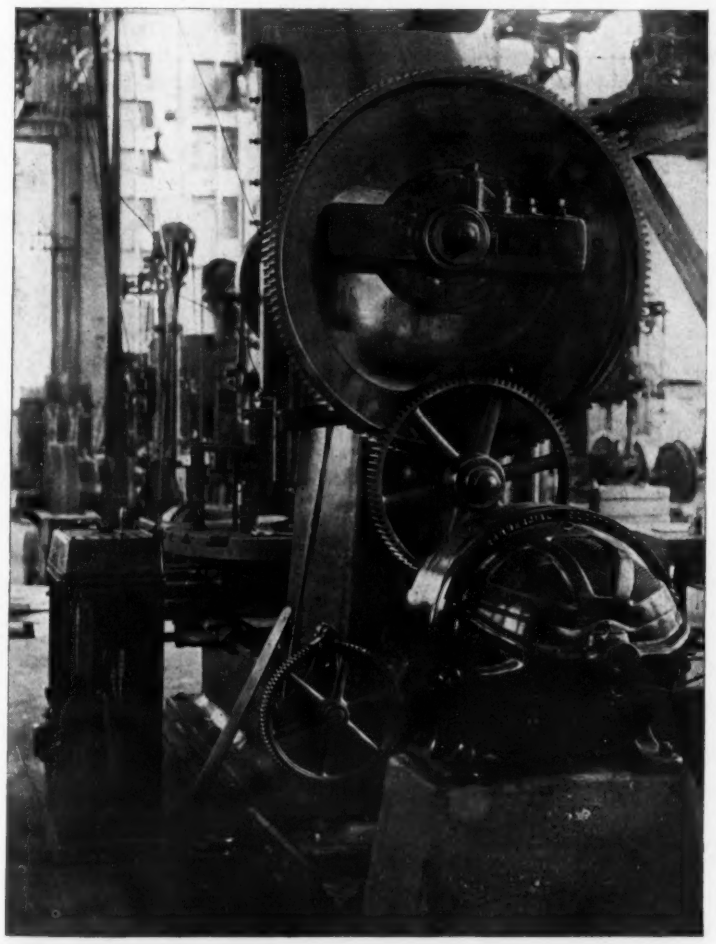


FIG. 4.—MOTOR APPLIED TO SLOTTING MACHINE.

The third speed, which is two and one-half times the slowest, is secured by operating independently the second winding having the smallest number of turns.

At these three fundamental speeds, the motor is operated with a maximum field strength. Intermediate speeds between these are secured by weakening the motor field, so as to increase the speed to a maximum of about 40 per cent. above the first and second fundamental speeds and 60 per cent. above the third fundamental speed. This makes the total range of speeds four-to-one, within which range the controller gives twelve speeds which are uniformally spaced between the highest and lowest. No armature resistance is used, consequently there is no power wasted in useless heating of resistance coils, and no drop in speed from no load to full load, except that occasioned by the slight resistance of the armature.

Fig. 1 is a diagram of the system, and Fig. 2 give efficiency curves of a 5-hp, 220-volt variable speed motor. Fig. 4 shows the motor as applied to large slotting machine, giving also a view of the con-

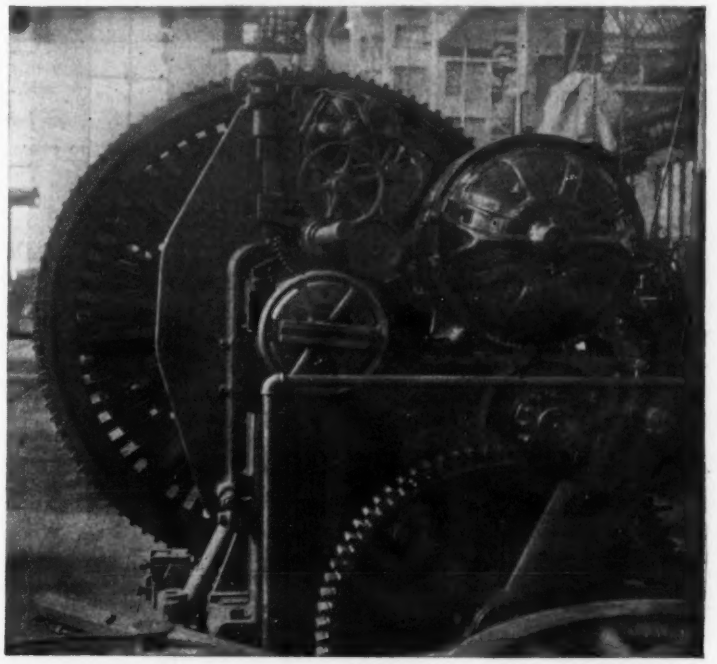


FIG. 5.—MOTOR-DRIVEN LATHE.

troller. Fig. 3 represents the speed changes with a 7½-hp motor direct-conected to a Barrett cylinder boring machine, all the speeds being obtained electrically. The range of speed is from 325 to 1,300 r.p.m. Fig. 5 shows a large electrically-driven lathe.

Great Northern Power Co.'s Plans.

Construction work has begun on what is claimed will be before ultimate completion the most important combined hydraulic and electric power proposition in the United States, with the exception of Niagara. The project is that of the great Northern Power Company, incorporated under the laws of the State of Minnesota. The company whose financial arrangements have just been completed, proposes in the first instance to develop some 30,000 hp, while the entire scheme involves a generating capacity of no less than 200,000 hp. All the streams and falls available for power at the head of the lakes are controlled by the company, including the St. Louis River Rapids, formerly owned, for more than thirty years, by Mr. Jay Cooke, of Philadelphia. Lake Superior, the most extensive body of fresh water upon the globe, derives its source from the St. Louis River, the largest river flowing into any one of the great lakes. Its waters form the magnificent Duluth-Superior Harbor. Within a distance of about six miles from the city limits of Duluth, the St. Louis in falling forms rapids which make possible the use of its waters for power under an effective head of 435 feet. At one point on the river, with an effective head of 365 feet, it is estimated that by the aid of reservoirs, fully 80,000 hp can be developed, and at the foot of the rapids there will also be available under an effective head of 70 feet, about 12,500 hydraulic hp. It is estimated that upwards of 100,000 electric hp can be developed from the proposed Duluth Heights system under an effective head of about 740 feet, so that the ultimate amount of power capable of development is calculated at 200,000 hp. The Duluth Heights project entails the carrying of a portion of the head waters of the St. Louis River and other streams and lakes north of Duluth through a canal and pipe lines

directly into that city, for general distribution in the mains.

In addition to transmitting electric energy to Duluth and Superior the company proposes to supply power to various mines and mining towns in the Messaba and Vermillion iron ranges. These mines and towns now utilize upwards of 50,000 hp of steam. Most of the coal consumed in Duluth and the mines must be carried over one thousand miles. Bituminous coal in large quantities costs $3.50 a ton and upwards at Duluth, and $4.50 a ton and upwards at the mines. On the iron ranges, as there is a great difficulty in procuring for boilers, water sufficiently free from mineral substances, the use of electric power is especially desirable. The operation of widely distributed small plants throughout the mining districts also makes the use of electric energy particularly advantageous. The annual output of these mines aggregates about 15,000,000 tons of Bessemer ore. The United States Steel Corporation, which largely controls this huge output, intends, it is understood, to convert the steam roads, which now carry the ore, into electric railways.

The initial power house is to be built at Thomson, a point on the St. Louis River about fourteen miles from Duluth. Here the effective head to be obtained will be 365 feet. The capacity of this plant in the first instance, will be about 30,000 hp. There will be three 13,000 maximum hp Francis type pressure turbines installed, arranged for direct connection to generators of about 8,000-kw, 600-volt capacity. There will be three pipe lines about two miles long.

The Great Northern Power Company directorate is composed of Messrs. J. Horace Harding, Henry C. Butler, Jay Cooke the third, and C. B. Coxe, representing the banking house of Chas. D. Barney & Co., of New York and Philadelphia; Richard Santonstall, Chauncy Eldridge, Thomas Pettigrew and Howard St. C. Eldridge, representing the financial house of Tucker, Anthony & Co., of Boston; Capt. McDougall, who is connected with the transportation interests of the United States Steel Corporation; T. F. Cole, head of the mining department of the same concern; C. C. Cokefair, F. A. Cokefair, A. M. Marshall, C. A. Duncan and F. A. Patterson, of Duluth.

The president of the company is Mr. C. A. Duncan, of Duluth. The vice-president is Mr. J. Horace Harding, of New York. Mr. W. A. Tucker, of Boston, is the treasurer. The secretary is Mr. Oscar Mitchell, of Washburn, Bailey & Mitchell, of Duluth. Messrs. C. A. Duncan, A. M. Marshall and Capt. McDougall constitute the executive committee.

The work of constructing the big Thomson plant will be under the supervision of Mr. F. A. Cokefair, the chief engineer of the company. Associated with him will be Mr. Thomas Pettigrew, chief engineer of the National Railway Construction Company, of Boston, and Mr. F. O. Blackwell, formerly chief engineer of the mining department of the General Electric Company, and now practising at 49 Wall Street, New York City. Mr. Blackwell will act as chief consulting engineer. These three gentlemen will constitute a committee for the purpose of determining the character of the work, the letting of the contracts, selection and purchase of equipment, etc. Mr. W. A. Brackenbridge, superintendent of the Niagara Falls plant, will also be retained on the staff of special consulting engineers. The former efficient force of assistant local engineers associated with the company during the period of preliminary work will be brought into requisition.

The old timber dam upon the St. Louis River at Thomson has been blown out and coffer dams erected preparatory to laying the foundation for the new concrete dam across the river at that point. This new dam will be about 600 feet in length by 40 feet high.

The Rice Lake dam will be built during the spring and summer months. The main generating station on the river, the distributing station at Duluth, the fourteen-mile transmission line connecting the two stations and other work will also go forward simultaneously with the construction of the dams, canal, head gates, etc. Upwards of 1,000 men will be employed on different parts of the construction.

Mr. C. C. Cokefair, who, with his son, Mr. Francis A. Cokefair, as chief engineer, originally incorporated the great Northern Power Company, and under whose successful exploitation during the past five years, it has developed into one of such importance, now that it has been successfully financed and the various departments of work fully organized, will hereafter devote much attention to the establishment of other industries in Duluth, which will utilize power generated by the company. Mr. C. C. Cokefair will keep in close touch with the progress of the company, without, however, devoting as much time as heretofore to the details of the general management.

It is expected that the Thomson plant will be in active operation by the middle of next year.

Demand Meters in Boston.

It is interesting to know that the Edison Electric Illuminating Company, of Boston, which began in 1898 to experiment with the Wright demand system of charging, and has steadily since that time extended its use, is now making as rapidly as possible, a final extension of the system to all its customers for light and power. Whereas up to the present time the Wright demand indicator has been used only to measure the consumption of customers having fifteen lights or more installed (the demand of customers having less than fifteen lights being assumed equal to the installation), its use is now to be extended to measure the demand of all contract customers having five or more lights. To make the above mentioned extensions, over 4,000 Wright demand indicators will be required, orders for which were placed with the General Incandescent Arc Light Company this autumn.

It must also be a matter of interest to central station men that with the extension of the Wright system, the Boston Edison Co. will put into effect a scale of rates which it is expected will completely do away with the inconvenience and expense of figuring out what rate a customer is entitled to. This new scale of rates is designed to give to each customer automatically the proper rate, that is, a rate having as nearly as possible a definite ratio to the cost of supplying him.

Hyatt Roller Bearings.

Prof. Arthur L. Williston, of the Pratt Institute of Technology, has recently made some comparative tests to determine the friction of several types of bearings under various pressures and at different speeds, and also to determine the starting torque or the turning

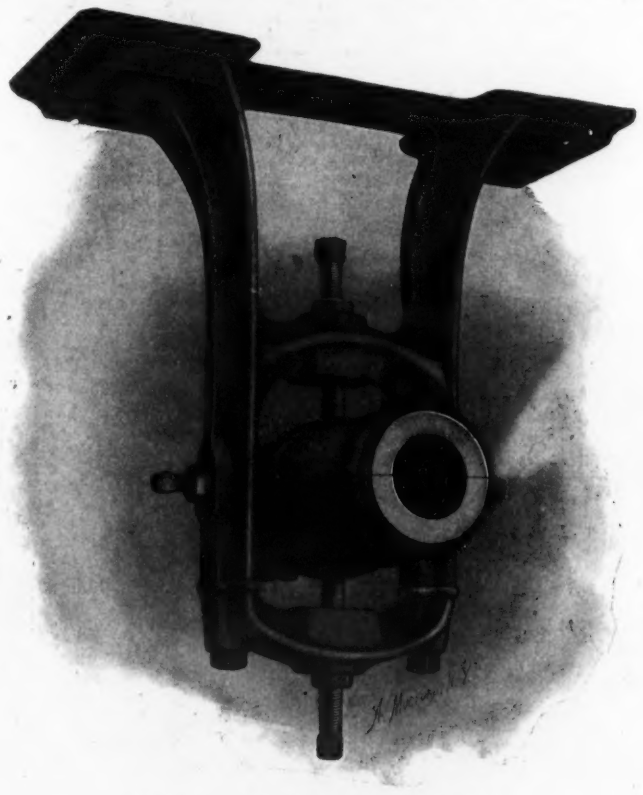


FIG. 1.—ROLLER BEARING HANGER.

moment necessary to move a shaft in its bearings under different loads, starting from rest. The bearings tested were four boxes of bronze bearing metal, four solid cast-iron boxes and four Hyatt roller bushings. In each case the bearing was 4 in. long for a shaft 1½ in. in diameter.

The cast-iron boxes were reamed to exact size and lapped to insure a perfect surface with a high degree of polish before the

tests were begun. The boxes of bronze bearing metal were reamed and lapped in the same manner as the cast-iron boxes. The roller bushings had the Hyatt flexible rollers running in a soft steel sleeve enclosed in a cast-iron box with a spacer or yoke to keep the rollers in line. The accompanying illustrations clearly show this bearing as made for application to shafting.

The method of testing provided for the taking of very accurate data as to two speeds and pressures. A moderately heavy mineral machine oil of good quality was used throughout the tests. The load was applied to the bearings by means of a ball bearing screw jack so arranged as to equally distribute the pressure at the center of the four boxes in each case. The pressure was increased at approximately equal amounts from about 80 pounds per sq. in. to 345 pounds per sq. in., or to the point at which the boxes would "seize" the shaft. Following are some of the results of the tests:

The coefficient of friction for the roller bearings was small and uniform, decreasing slightly, however, as the pressure increased and becoming a minimum at a speed of about 300 r.p.m. The average coefficient of friction for the entire series of tests was found to be .0118.

The coefficient of friction for the cast-iron bearings increased rapidly as the pressure increased, and when the total pressure was over 250 pounds per sq. in. there was difficulty to keep the boxes from "seizing" the shaft. The series of tests was not continued beyond the speed of 410 r.p.m., because of the excessive heating of the boxes which made efficient lubrication impossible. The average coefficient of friction for the entire series of tests was .0608, or 5.1 times as large as the coefficient of friction for the roller bearing.

The coefficient of friction for the bronze boxes increased rapidly as the pressure increased and also increased rapidly for the higher speeds at pressures above 145 pounds per sq. in., and there was difficulty from keeping the boxes from "seizing" the shaft. The average coefficient of friction was found to be .112, or 9.5 times the average coefficient of friction for the roller bearings. While it may to some appear surprising that the coefficient of friction for the bronze bearings was considerably higher than that for cast iron, on

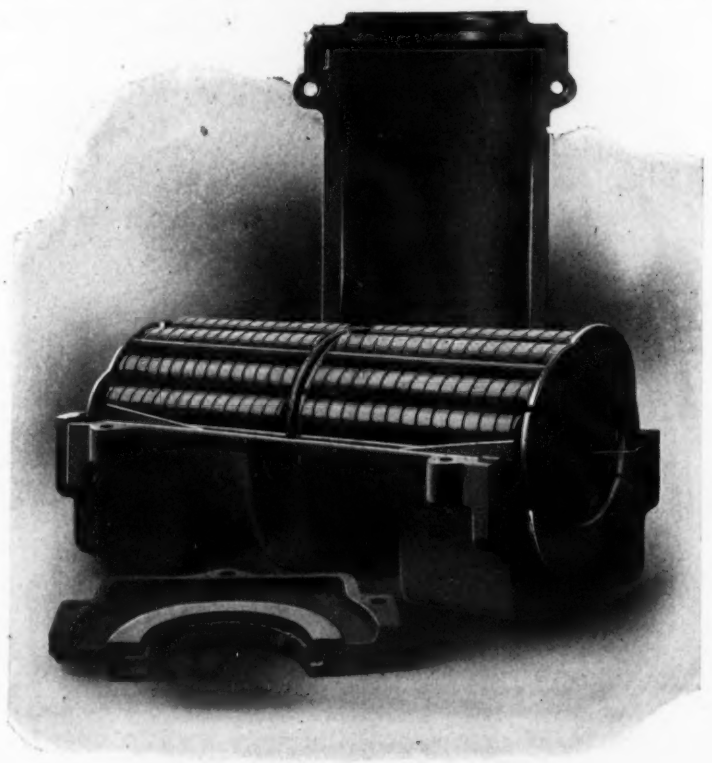


FIG. 2.—ROLLER BEARING.

the other hand it is known that cast iron is an admirable bearing material so long as its surface can be maintained in perfect condition and so long as there is perfect freedom from dirt and grit, and when there is perfect lubrication. The valuable property of bronze as a bearing metal is the fact that it does not readily become scored or cut by the presence of dirt or poor lubrication as does cast iron.

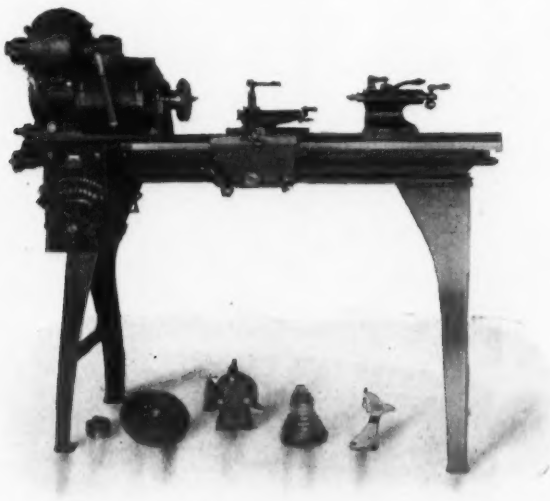
The temperature with the cast iron and bronze boxes, after a run of about 30 minutes at a speed of 585 r.p.m. and a pressure of 345 pounds per sq. in., was above the boiling point of the cylinder oil used and too great to be determined with a thermometer. On the other hand, the maximum rise of temperature with the roller bearing was but 6° F. With both the cast-iron and bronze boxes there was difficulty in maintaining the shafting in good condition. The roller bearing, on the other hand, had a tendency to polish the shaft, which at the end of each series of tests was found in a better condition than at the beginning.

As to starting torque, the average coefficient of friction for the roller bearing was found to be .0058 or identical with the average coefficient of friction determined when the shaft was running at speeds varying from 130 to 585 r.p.m. The average coefficient of friction for the bronze bearings was .091, or 15.7 times as great as the coefficient of friction for the roller bearings. A test was also made as to the starting torque with babbitt bearings, and the coefficient of friction in this case was found to be .089, or 15.3 times the coefficient of friction for the roller bearings.

Among the conclusions from the tests, aside from those above referred to, are that very high pressures are possible with the roller bearing without appreciably increasing the coefficient of friction; the rate of wear of the roller bearings was found to be less at the time of the tests than could be measured with ordinary means, while with the other bearings during the same time the wear was very appreciable; the Hyatt roller bearing, owing to its construction and to the fact that the spirals are right and left, furnishes a most perfect means of self-lubrication, and there is not the same danger of injury to a journal from dirt and grit as in the case of cast iron and bronze; inaccuracies in size and alignment of shaft were found to be far less serious with the roller bearing than with the solid boxes; where the clearance between the bearing and the shaft is large, the coefficient of friction for the roller bearing becomes still smaller and the ratio between it and the friction of the solid boxes becomes correspondingly greater.

Lathe With Direct Driving Motor.

The accompanying cut shows a 9-in. by 5-ft. "Star" engine lathe driven by direct connected electric motor, and is more than ordinarily interesting on account of the lathe being unusually small. The motor, which is of the variable speed type, made by the Northern Electrical Manufacturing Company, is ⅜ hp for a direct current of 110 volts, and is speeded from 1,000 to 2,000 r.p.m. The lathe spin-



ELECTRICALLY-DRIVEN LATHE.

dle has 48 speeds (ranging from 15 to 420 r.p.m.) which are obtained by a speed controller with 16 changes and double back gears on lathe. The back gears are connected by clutches which may be thrown in or out while in motion. The gears in the head stock run in oil, and are thoroughly lubricated at all times.

This lathe was built by the Seneca Falls Manufacturing Company, Seneca Falls, N. Y., for one of their customers in St. Petersburg, Russia, and is of the regular construction with the exception of the special head stock.

Tests of Machine-Tools Electric Drive.

A test was recently made on a 36-in. Draper triple-geared lathe driven by a 15-hp Westinghouse direct-current motor designed to run at 875 to 1,600 r.p.m. by field control, and equipped with the rheostat controller recently brought out by the American Electric & Controller Company, New York. By the addition of this controller the total number of speed changes were 100 and the total range of spindle speeds varied from 2.69 r.p.m. to 257.5 r.p.m. The lathe head provided only five changes of speed by means of gearing through a total range of spindle speeds of 6.71 r.p.m. to 140 r.p.m.

In the case of the gear changes it was necessary to stop the lathe,

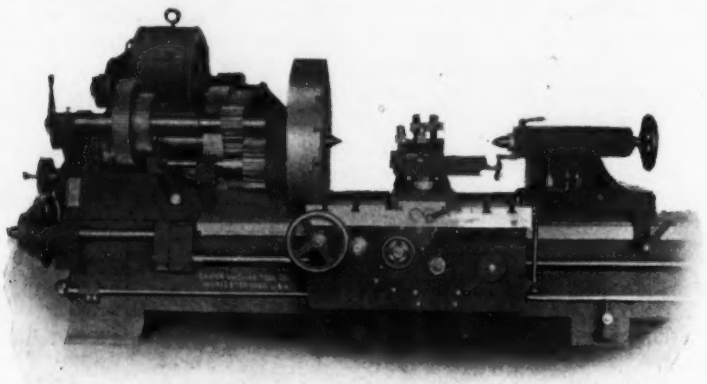


FIG. 1.—ELECTRICALLY-DRIVEN LATHE.

which included shutting off the power and waiting for the spindle to come to rest, after which the gears formerly in mesh had to be thrown out and another set thrown in. The time required for this operation varies greatly with various operators, but in the best of cases represents a serious loss. With the rheostat control, the 4½ to 1 range of speeds can be made without stopping the lathe, the operator remaining in his position at the apron, and necessitates but one setting of the gears for any one job. Thus in the course of a day a great deal of time can be saved.

Moreover, if the job is that of surfacing a face plate or large flange, the minute changes in speed procurable through the electric control by the "rheocrat" makes it possible to maintain practically

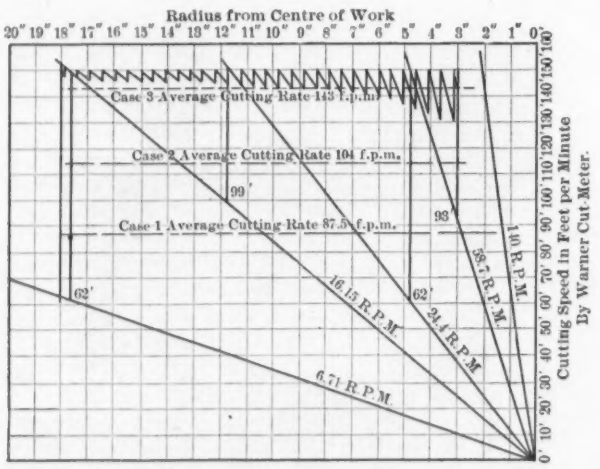

Radius from Centre of Work
20" 19" 18" 17" 16" 15" 14" 13" 12" 11" 10" 9" 8" 7" 6" 5" 4" 3" 2" 1" 0
Case 3 Average Cutting Rate 143 f.p.m.
Case 2 Average Cutting Rate 104 f.p.m.
Case 1 Average Cutting Rate 87.5 f.p.m.
99'
93'
62'
62'
16.15 R.P.M.
6.71 R.P.M.
24.4 R.P.M.
58.7 R.P.M.
140 R.P.M.
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Cutting Speed in Feet per Minute
By Warner Cut-Meter.

FIG. 2.—TEST OF MOTOR-DRIVEN 36-INCH LATHE.

constant cutting speed. The controller handle can, by an adjustable clamp, be geared direct to the cross feed of the lathe, making the maintenance of the constant cutting speed entirely automatic. The accompanying tables show the relation of speeds obtained in the present case. The job on which the test was made was that of surfacing the regular driving face plate of the lathe. Allowing a maximum cutting speed of 150 ft. per minute the time required for making two cuts, one roughing and one finishing was as follows:

Case 1.—No changes made in gearing, assuming that the average workman will not take the time or trouble to make them. No electrical changes, assuming that the motor is constant speed with no controller. The highest average cutting rate possible is 87.5 ft. per minute; time of two cuts, 10.7 minutes.

Case 2.—Four changes made in the gearing, no electrical changes, assuming that the motor is constant speed with no controller. Average cutting speed 104 ft. per minute; time of two cuts, including time required for change of gears (estimated at 5 minutes), 14.5 minutes.

Case 3.—Twenty changes of speed by controller; one change by gearing; average cutting speed 143 ft. per minute; time for two cuts, including time required to change gears, 7.5 minutes.

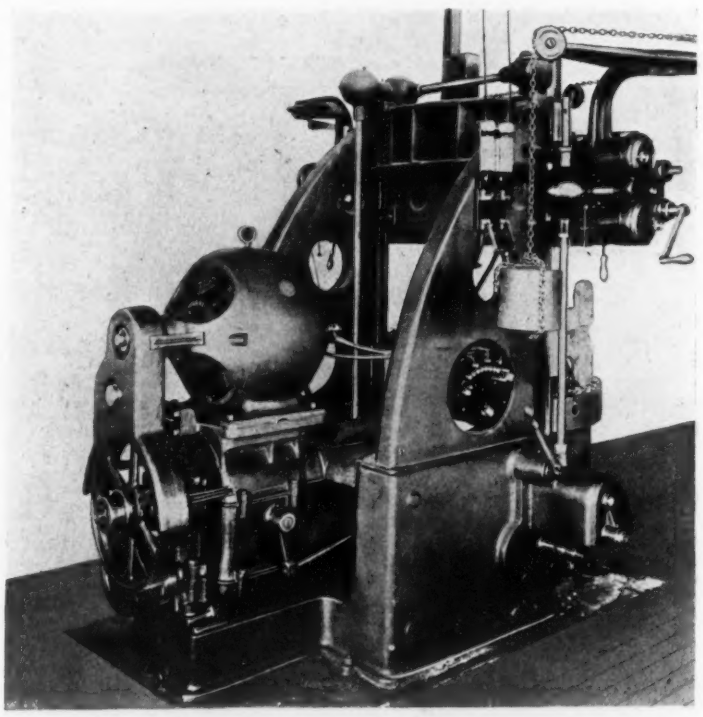
COMPARISON OF SPEED RANGES BY GEARS AND ELECTRIC CONTROL.

Single Belt Drive to quill running 140 R.P.M.		Combined armature and field control by "Rheocrat."
Gearing.	R.P.M. of Spindle.	R.P.M. of Spindle.
1st back gears and triple gears	6.71	2.69 to 12.3
2d back gears and triple gears	16.15	6.46 to 29.5
1st back gears only	24.4	9.8 to 44.75
2d back gears only	58.7	23.22 to 107.2
Gears all out	140	56.3 to 257.5
Total number of changes ..	5	100

The above figures are graphically shown in the accompanying diagram. The actual saving in time by the electric control as compared with motor or any other drive providing only gear changes, is more than 42 per cent. In the case of vertical boring mills and many special tools, the saving is many times greater.

Spherical Type Motor.

The accompanying illustration shows the spherical type of motor made by the Electric Machinery Company, of Minneapolis, Minn., as direct-connected to a vertical boring mill, in which service it has been employed for about a year with great satisfaction to the user. The motor, which runs at constant speed, is started by means of an ordinary starting box. The changes of speed are obtained by the gearing of the boring mill. This type of motor is built for direct-connection to all kinds of machine tools, either for constant or



SPHERICAL MOTOR CONNECTED TO BORING MILL.

variable speed. In the latter case the change of speed is effected by field control giving a constant output over the whole range of speed. The motors are wound for 110, 220 and 500 volts. The magnet frame is made of a special steel which is tested for its magnetic qualities. The armature has been designed to meet all of the requirements of the special service of the motor, good ventilation and suppression of eddy currents being carefully provided for. The commutator is also of a special design, preventing the possibility of "high" and "low" bars, and providing a very large number of segments. The construction of the brush holder is such that it cannot turn on its stud when once properly set, or for the stud to shift or get out of alignment. When turned to bring the brushes to the neutral point, the holder is securely locked in that position.

Mill and Factory Motor System of Burke Electric Company.

The Burke Electric Company, lessee of the Keystone Electric Company, of Erie, Pa., is establishing after entirely new designs a line of motors, both constant and variable speed, for application to driving every class of machinery found in mills and factories. A number of patents have recently been issued covering the various details of these motors, the inventor being Mr. James Burke, for some years with the Union Electricitäts Gesellschaft, of Berlin, and who has studied machine tool problems for many years, both in Europe and this country. The motors now being made by his company, or which will soon be added to its line, embody the results of his wide experience, both in technical design and in commercial applicability to all classes of shop work.

The policy of the company has for its principal aim the building of motors especially adapted and suitable to machine tool applications. Heretofore companies have usually followed the practice of utilizing standard machines, built for other purposes, and adapting them to machine tool problems. In the present instance, there is no handicap through tradition, patents, dies or special tools belonging to types of machinery not suitable to the purpose, the company being free to start from the ground up with a line of machinery with a single object in view, namely, the driving of machine tools and allied machinery. The line of motors will, however, be applicable to other commercial purposes on account of their especially rugged nature and liberal features of design.

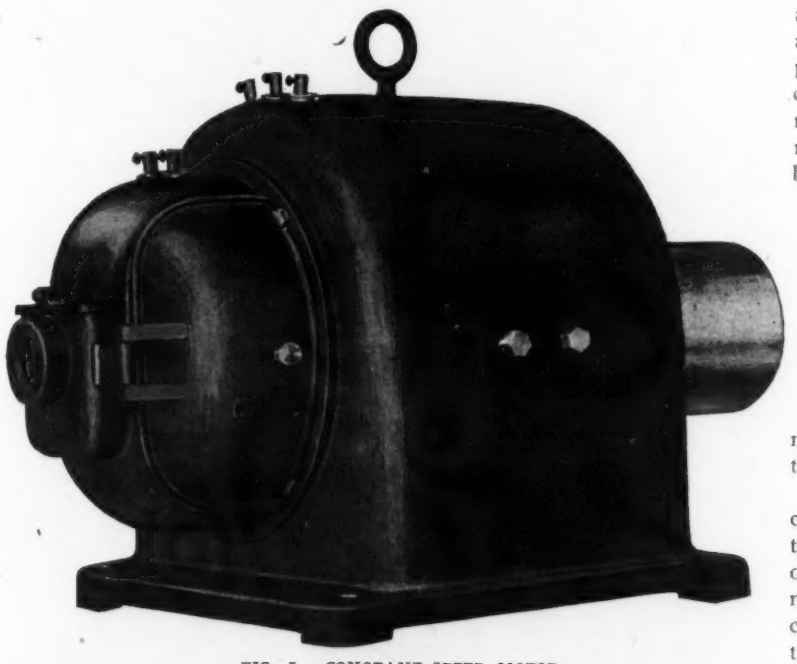


FIG. 1.—CONSTANT-SPEED MOTOR.

Fig. 1 shows what is called the "AB" constant speed type of machine, which starts with the smaller sizes and extends to 7½ hp. These are bipolar and are followed by type "AM" machines, which are multipolar, and extend on up to the largest sizes required in practice. Fig. 2 is an efficiency curve of the first-mentioned type, taken from actually observed data of performance, and which, we are informed, has been carefully verified, in view of the very high efficiencies it indicates. The smaller machines, of course, have somewhat lower efficiencies, while larger machines have shown even higher efficiencies. The totally enclosed frame shown in the illustration is preferred for the majority of machine tool applications where chips and filings may fly from tools and bench workers, and accidentally get into the motors. It is also made in a ventilated enclosed type, which permits of some breathing of the motor while still giving adequate protection.

A characteristic feature of this type of motor is the interlocking commutator bar, shown in Fig. 3. This is claimed to be the only construction which absolutely locks each bar to the bar adjacent to it throughout the length of the commutator, resulting in the perfection of commutator building and the prevention of irregular surface on the commutator due to high and low bars and high or low mica. Such a construction is of great importance in variable speed motors where the maximum speeds are often extremely high. Commutator troubles resulting in sparking at the brushes are not absent from ordinary motors, but with the extremely high commutator surface speeds of variable speed motors often met with, these troubles are apt to become serious with the usual commutator construction.

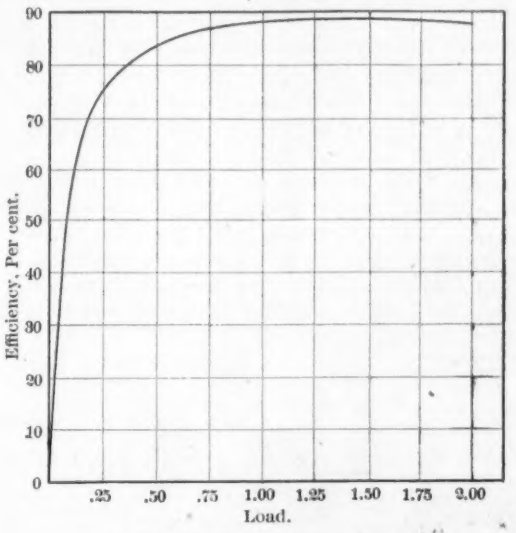


FIG. 2.—EFFICIENCY CURVE OF MOTOR.

The variable speed type of motor is built for a speed variation of anything desired up to 4 to 1 as standard machines, and up to 6 to 1 as special machines. The entire speed change in all instances is produced by variation of the shunt field of the motors. This is accomplished by means of a drum controller which also has the steps for reversing the motor, and which gives, when desired, the entire speed range in both directions. In lathe work the controller is operated by a lever which travels with the apron of the lathe, and other special

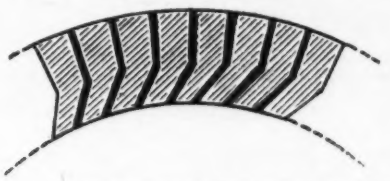


FIG. 3.—INTERLOCKING COMMUTATOR BAR.

mechanical attachments have been worked out for various other types of machine tools.

The rating of the motors has been determined with respect principally to the machine tool, the motor being so proportioned that the operator of the machine will not have to consider the question of motor capacity but can forget that there is such a thing as a motor attached and can work the machine tool to the limit of its capacity. These conditions will be complied with if the manufacturers' recommendation as to sizes of motors for each class of machine tool is adopted, their theory being that instead of educating the machinist, to be an electrician in the care of the motor driving his machine tool, he should be furnished with motors which will become in themselves part of the machine tool and be as rugged and substantial as anything else in the machine to be operated.

Electrically-Driven Boring and Turning Mill.

A type of machine designed especially for the heavy duty now demanded by progressive manufacturers is offered in the vertical boring and turning mill which forms the subject of the accompanying illustration. The machine is equipped with numerous devices for the economy of labor, which have the effect of increasing its capacity for the general run of work for which it is adapted.

The driving mechanism consists of a powerful friction back-geared headstock with three ratios of back gearing obtained through sliding gears. The six changes of table speed are obtainable for each speed of the main driving shaft. The levers for operating the friction head and the sliding gears are convenient to the operator when standing in his usual position. The friction clutch is operated from either side of the machine.

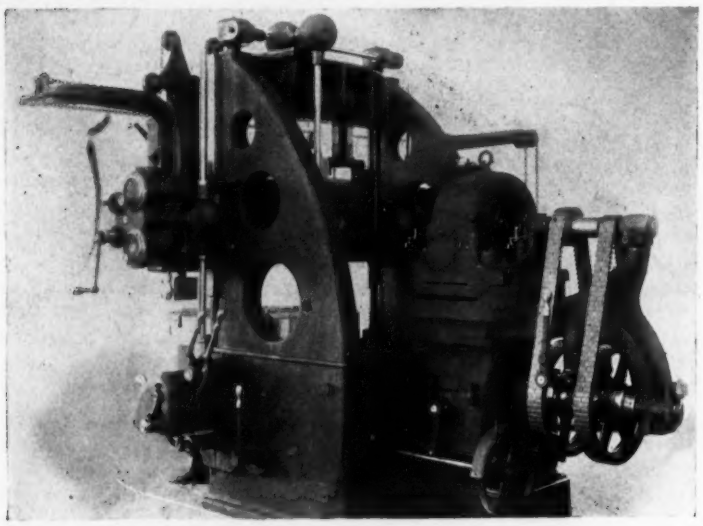
Ten changes of speed are provided for both heads—the feed for

each head being independent. A friction device, which may be practically positive, prevents injury to the gearing should the heads run together. Automatic trips are provided for both the gears and the up-and-down feeds so that the feed may be thrown out automatically at any predetermined point. There are also micrometer dials provided for the definite feeds, thereby reducing the amount of calipering to a minimum.

On all sizes of machines larger than the 42-in. the heads are moved in and out, and the slides are operated up and down by power, the mechanism operating in such a way that a slight change of a lever, when a feed is in, will throw in the rapid movement mechanism of the head.

The heads may also be easily adjusted when the table is at rest, thus guarding against any damage due to having the heads run into the work while it is revolving. On the 42-in. machine and smaller sizes, the distances to be traversed by the heads are so short that the fast speed obtained by the friction clutch allows them to travel as fast as necessary, so that no power-driven rapid traverse is provided for the heads.

The wearing surfaces are made very large, to insure good



ELECTRICALLY-OPERATED BORING AND TURNING MILL.

lubrication of the machine. All of the gears are encased, while provision is made for completely protecting the driving chains. In the illustration the cover is removed from the chain in order to show the driving mechanism.

These machines are especially designed for direct connection to electric motors by means either of gears or silent chains. Motors having a 50-per cent. speed variation, say from 600 to 900 r.p.m., will serve all ordinary requirements.

These machines are made in six sizes, ranging in swing from 34-in. to 72-in. The manufacturer is the Gisholt Machine Company, of Madison, Wis., which has given considerable attention to the matter of electric drive.

Richmond Machine Shop Motors.

The accompanying illustrations show the application to machine tools of a type of motor especially designed for this work by the Richmond Electric Company, of Richmond, Va. One of the features claimed for the motors of this company as rendering them particularly suited for machine tool driving, is that they are so designed as not to spark or flash under very heavy overloads. For example, it is stated that a 5-hp, 500-volt motor will not commence sparking under 15 to 20 hp even with the brushes set at the neutral point and not adjusted for direction of rotation. It is thus possible in starting to throw four or five times the normal current upon the motor without injuring the machine, which can be reversed under the same conditions. It will thus be seen that the motor is particularly suited for quick starts and stops and reversals of a machine tool and suitable for direct connection thereto.

The railway type of field coils have been used throughout as being most durable and capable of standing the hardest service. The railway method is employed of bringing the leads of the machine out through rubber bushings of the frame, which construction avoids unreliable porcelain or slate terminal boards, which so frequently are the cause of short circuits and shocks to employees. The motor heads are held on by four cap screws, and the heads can be turned in the frame to enable the machine to be located on the floor, overhead or placed on a vertical surface. The poles are set on 45° centers, so that for floor, wall or ceiling use there is no bottom field coil to become saturated with any oil or water which may get into the machine.

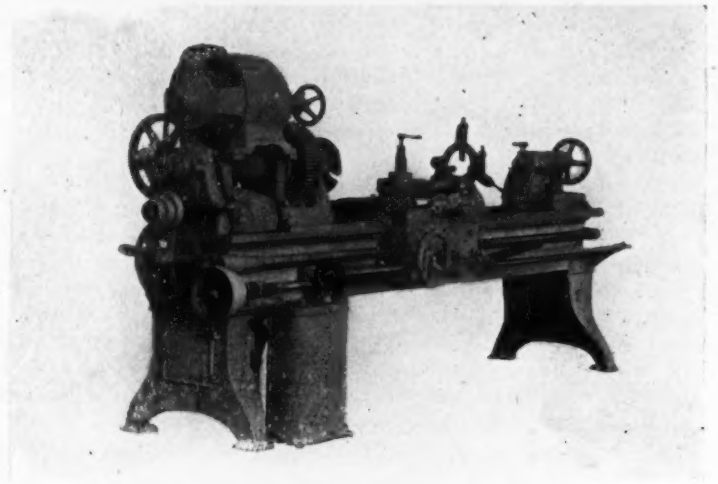


FIG. 1.—MOTOR-GEARED MACHINE TOOL.

The brush-holder ring is provided with stops in order to prevent the brushes from being carried out of the neutral or proper running position. The heads of the armature, comprising in one piece the oil slingers and thrust collars, are shrunk upon the armature shaft, thus preventing any possibility of oil creeping along the shaft and getting into the commutator and windings.

The commutators are readily removable from the armature without taking any coils off the machine, and the ring lock nuts are turned toward the winding so as to add an additional safeguard

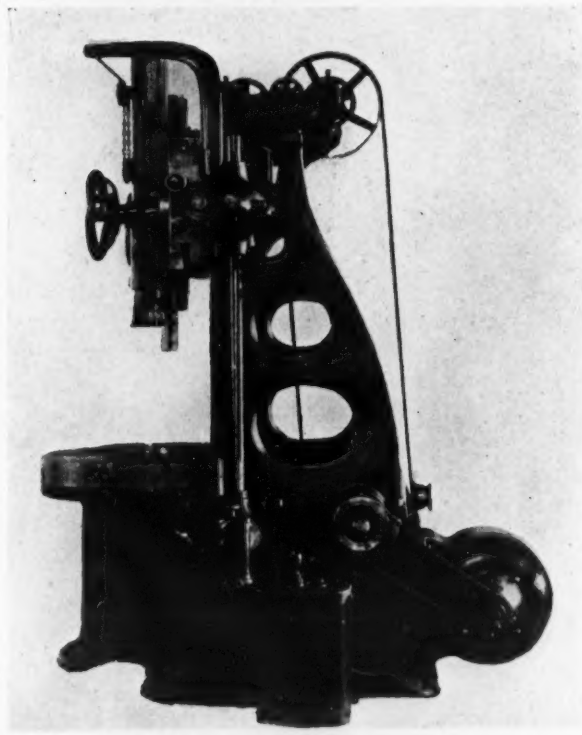


FIG. 2.—MACHINE TOOL DRIVEN BY CHAIN.

against oil from the bearings creeping into the commutator. The commutators have considerable depth of segments, thus insuring long life; the leads from the coils are not soldered in the segments, the segments being milled a few thousandths smaller than the width of the leads and the leads forced into the commutator bars, thus avoiding the use of solder or soldering fluids. This method gives a very substantial construction.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.—There is a more general feeling of confidence resulting from the resumption of outdoor work and the opening of spring trade. Weather conditions are favorable in most sections of the country and there is little interruption because of labor controversies. Some inconvenience was caused in New York by the strike on the Interborough Rapid Transit lines, and retail trade suffered temporarily, but in the aggregate the commercial loss was not extensive. The most gratifying news of the week emanates from the iron and steel industry, where unprecedented output of pig iron is not productive of accumulated stocks. Other leading manufacturing operations are making steady progress. Deliveries of steel billets and bars are eagerly sought, and orders for construction material are taken only on condition that deliveries in less than four months are not to be expected. A record in building is looked for all over the country this year. On the Pacific Coast the lumber situation has improved, and hardware is in general demand. The merchandise movement in practically all sections, save a portion of the south, has expanded considerably; the railways have begun to win out of their car-congestion troubles, and are handling a very large traffic, and preparations for an active building are reflected in the markets for material. The copper market was extremely dull, and prices are nominally unchanged. Lake is quoted at 15¼ to 15⅜c.; electrolytic, 15⅛ to 15¼c.; casting stock, 14⅞ to 15c. The number of business failures during the week ended March 9, as reported by *Bradstreet's*, was 190, against 206 the week previous and 200 in the corresponding week last year.

CALIFORNIA WATER-POWER PROJECT.—The construction of a 24,000-hp hydro-electric plant is contemplated at Sublett's Crossing on the Middle Fork of the Stanislaus River, about 130 miles from San Francisco. Sanderson & Porter, New York City, will be the engineers. The drainage area is 340 square miles, and is almost entirely within the National Stanislaus Forest Reserve. This watershed varies in altitude between 2,500 and 11,500 ft., most of it being over 6,000 ft. The scheme includes the acquisition of the rights to 300 cub. ft. of water per second, of which it is proposed to utilize 180 cub. ft. for the generation of electric power. The development will consist of a storage reservoir in the mountains having a capacity of 500,000,000 cub. ft., which will be utilized to equalize the flow during periods of extreme drought, so as to insure a continuous flow of not less than 180 cub. ft. per second. A dam and intake at a point called Sand Bar Flat will be built so as to divert the water from the river into the flume and ditch system, 15½ miles long, and to have a capacity of 300 cub. ft. This will be discharged into an equalizing reservoir, having a capacity of 10,700,000 cub. ft., to be located immediately above the power house site. The pressure pipe system will deliver 180 cub. ft. of water per second to the power house and 120 cub. ft. across the Stanislaus Canyon for distribution and sale or other purposes. The power house will be equipped with polyphase equipment. The water will be utilized under an effective head of over 1,400 ft. It is proposed to transmit the current for use in the manufacturing and agricultural districts lying between the power house and San Francisco. About $4,000,000, it is estimated, will be expended in the carrying out of the enterprise.

COLUMBIA RIVER POWER ENTERPRISE.—Mr. M. D. Kelley, 109 Marion Avenue, Seattle, Wash., writes us with regard to an interesting enterprise for which the best and latest developed machinery is required. He and associates propose to take out of the Columbia River water in sufficient quantity to irrigate 8,000 acres of land by gravitation, and to furnish power enough to generate current for manufacturing lumber and flour, as well as to supply current for electric roads and pumping plants, adequate to the irrigation of three tracts of fine agricultural land, containing, respectively, 70,000, 160,000 and 184,000 acres. There is a head of 78 feet from the crest of the rapids to the foot, in a distance of 11 miles. The ditch is to be 20 feet wide at the bottom and 40 feet at the top. There will be a cut of three miles from the head of rapids to bring the water out on top of level ground. At the deepest point the ditch will be 30 feet. The excavators will find boulders, gravel, sandrock and volcanic ash. In building this water way, the lateral ditches and reservoir on the 70,000 acres will be built at the same time that work is being done on the power ditch. The engineers' estimate of the cost of this project is $687,000.

RECONSTRUCTION OF MEXICO CITY LIGHTING PLANT.—The old Siemens-Halske lighting plant in Mexico City, which was recently destroyed by fire, is being reconstructed with all possible speed by the Mexican Light & Power Company, Limited, the Canadian syndicate, of which Mr. F. S. Pearson is the consulting engineer. The Mexican company now controls the lighting franchise in the capital of the southern republic. The original plant was equipped with German machinery. The new plant will be installed with American apparatus throughout. The General Electric interests have secured the contract for the generators, etc. The construction of the new station has been placed in the hands of the Riter-Conley Company, 39 Cortlandt Street, which concern is also executing the contracts for the building of the huge Necaxa water power plant and the substations at Mexico City and El Oro. The Riter-Conley people also secured the contract for the steel towers—upwards of 2,000—for the Necaxa-Mexico City-El Oro transmission line, which will be the second largest on this hemisphere.

MORE MEXICAN POWER PROJECTS.—Mr. Pedro Armendariz has made application to the Mexican Government for the necessary permission to construct a hydro-electric plant on the Tamazula River, State of Durango. Sanction is also sought to import the material, equipment, etc., free of duty. Mr. Frank Turner, an American citizen, at present located in the city of Chihuahua, is primarily interested in a project to build a large water power plant on the river Aros, State of Chihuahua. The concession, which is now under consideration by the authorities, will permit of the utilization of 9,000 liters of water per second. The power is intended to be used for electric lighting, traction, mining and other industrial purposes. Mr. Andres Matienzo is also seeking a water power franchise. He proposes to build an hydraulic plant on the Atoyac River, vicinity of Texmelucan, Department of Huejolzingo, State of Puebla. The energy generated will be for lighting purposes principally.

VARIOUS EQUIPMENT, ETC., FOR JAPAN.—Mr. Francis A. Cundill, 90-96 Wall Street, New York, representing L. J. Healing & Company, of Yokohama, has lately placed several interesting orders for condensers, insulating fibre, tape, fans, switches, etc., in this market for export to Japan. The Platt Iron Works Company, 93 Liberty Street, has been allotted an order for a condensing equipment to be installed in the Yokohama Electric Railway Company's plant. The Diamond State Fibre Company, of Wilmington, Del., has secured a big order for insulated fibre and the Okonite Company is to fill a substantial order for tape. The Jandus Electric Company has obtained a desk fan order and the Crouse-Hinds Electric Company is also to ship considerable of its specialties to the Far East.

ELECTRIC RUBBER PLANT.—The Electric Rubber Manufacturing Company has acquired the old Hazelton Boiler Works, at Rutherford, N. J., and will largely reconstruct and re-equip the plant. Mr. James H. George, of 110 East Thirty-ninth Street, is president of the company. The general contract has been awarded to L. & J. Brandt, 169 East Eighty-fifth Street, New York City. A fair-sized electrical equipment will be installed. An Atlas engine has already been ordered.

MEXICAN TELEPHONE PROJECT.—An extensive telephone system is to be constructed by Mr. William Richardson, one of the large ranch owners in Mexico. A contract for a 100-mile line has already been awarded to Van Voorhis & Co., of Monterey, State of Nuevo Leon. This concern conducts an engineering, contracting and supply business, and handles quantities of American electrical equipment, etc.

TURBINES FOR UNITED SHOE FACTORY.—The United Shoe Machinery Company, which is building a huge plant at Beverly, Mass., will utilize electricity as a motive power throughout the factory. Steam turbines will be employed. Some forty motors will be operated on the group system.

TO BUILD GAS ENGINES IN MEXICO.—The National Iron & Steel Works, Durango, Mexico, which are among the largest of their description in the Southern republic, are perfecting arrangements to embark in the extensive manufacture of gas engines.

PLANT FOR MARBLE YARD.—Mr. C. O. Mailloux, consulting engineer, Bishop Building, William Street, is about to award contracts for a 500-kw. plant, to be installed in the Fisher marble yards, 138th Street and East River.

BIG ORDER FOR BRILL CARS.—The J. G. Brill Company, of Philadelphia, has been awarded 175 cars for Brooklyn Rapid Transit Company at a cost of $600,000.

ANOTHER CONCHOS RIVER PROJECT.—Mexican advices state that following the concession recently granted by the Federal Government to the United States Company, in which the John F. Kelly Engineering Company, Singer Building, is primarily interested, for the use of the waters of the Conchos River to generate electric power for utilization at Parral and other mining camps located in the State of Chihuahua, there is now under consideration by the Department of Fomento an application for permission to employ the energy of the same river at a point near Ciudad Camargo. The parties seeking this franchise are Mr. Pablo Gunther, a land owner and resident of Camargo, and Mr. Joaquin Cortazar, of Chihuahua City. They propose to build an immense masonry dam at a point called the Boquilla, where the Conchos River emerges from a canyon about five miles from the village of San Francisco Conchos and twenty miles from the city of Camargo. At a distance of 200 meters from the dam the power house is to be constructed, and a transmission line built to Camargo and the outlying mining district. The Kelly people's enterprise refers to the proposed La Joya hydro-electric plant. The concession is in the name of the Conchos River Power Company, which is incorporated under the laws of New Jersey. Dr. Kelly is president of the company. The secretary of the company is Mr. W. D. Kloman, who is also treasurer of the Kelly Engineering Company. Upwards of $1,000,000 gold will be expended. Power will be transmitted to Parral City, 44 miles, and to the city of Chihuahua, 80 miles distant from the power house site.

ALBERGER CONDENSER CONTRACTS.—The Alberger Condenser Company, New York City, has a number of foreign contracts in hand. The Manila Street Railway & Lighting Company, Limited, on whose account J. G. White & Co., 49 Exchange Place, is constructing the extensive lighting and traction system, has ordered Alberger condensing equipment for the power which is to take care of the lighting of the city. The order calls for a surface condenser of 6,000 square feet capacity, and a two-stage dry vacuum pump, also centrifugal circulating pumps. The Alberger people are also to ship a surface condensing plant to be used in connection with the steam turbine installation which the Westinghouse interests are to erect at Dawson City for the operation of gold dredging boats on the Yukon. The Canada Car Company, Limited, which is building a big car plant at Port Henri, near Montreal, has ordered an Alberger dry vacuum condensing system and a number of boiler feed pumps.

EQUIPMENT FOR SLAG CEMENT PLANT.—Considerable electrical equipment is to be installed in a 500 barrel slag cement mill to be built by the Ashland (Ky.) Iron & Mining Company. The contract for the construction of the mill has been awarded to Mr. C. J. Curtin, Taylor Building, New York City. There will be three electrically operated dryers built by the Ruggles-Coles Engineering Company, Taylor Building, each capable of driving off 3,500 pounds of water per hour from granulated furnace slag. After the slag is dried it will be electrically conveyed to four tube mills for further grinding. The Stanley Electric & Manufacturing Company of Pittsfield, Mass., secured the contract for the several motors to be installed. An order for a 600-hp engine has been given to the Atlas Engine Works, of Indianapolis, Ind.

J. G. WHITE GETS BUENOS AYRES CONTRACT.—The London firm of J. G. White & Co., Limited, has secured the contract for the conversion of one of the oldest mule roads in South America into an up-to-date electric traction system, viz., the Tramway Rural, which system was operated in and around Buenos Ayres, the principal city in the Argentine Republic, by Lacroze Brothers. The present road is about 25 miles long. It will be considerably extended. The White interests recently opened offices in Buenos Ayres. The orders will be placed through London, and those that come to this side will be handled through J. G. White & Co., 49 Exchange Place.

ANDERSON SWITCHBOARD ORDERS.—The Albert & J. M. Anderson Manufacturing Company, of Boston, Mass., New York offices, 135 Broadway, has secured the contract for the big switchboard to be installed in the power plant in the Washington, D. C., Navy Yard. There will be twenty-nine blue Vermont panels. Upwards of one hundred Cutter circuit breakers will be used on the board. The Anderson people have also taken the order for the switchboard for the new power plant for the Quintard Iron Works, New York City. An order for a good-sized test board has been given for the Dartmouth, N. H., College laboratories.

EQUIPMENT FOR TUNNEL PLANT.—The generators to be installed in the contractor's power plant for the Cortlandt Street-Jersey City tunnel, which undertaking is to be built by the McAdoo interests (Davies & Jacobs, 128 Broadway, engineers), has been let to the General Electric Company. The contracts for the main power plants will not be decided upon for fully six months. Mr. L. B. Stillwell has been retained as consulting electrical engineer for the installation work.

THE CHICAGO & NORTHWESTERN RAILWAY COMPANY has placed an order with Allis-Chalmers Company, of Milwaukee, for two Reliance 32-in. by 36-in. belted engines and two 250-kw. direct-current Bullock generators. These will be installed as two separate units in the power house of the company at Buxton, Ia., and used for driving machinery in the coal mines there, which furnish fuel for some of the western divisions of the road.

EQUIPMENT FOR SMELTERS.—The American Smelting & Refining Company, 71 Broadway, has decided to utilize about 700 kw. of electrical equipment at its Perth Amboy N. J., plant. The contract for the new power house has been awarded to the Riter-Conley Manufacturing Company. Mr. Herbert J. York is chief engineer of the American Company. The constructing engineer is Mr. W. A. Allen.

THE INDEPENDENT TELEPHONE COMPANY, of Topeka, Kan., recently ordered an additional equipment of private branch exchange switchboards. The Topeka company has secured contracts for equipping most of the local hotels with this class of service. The American Electric Telephone Company furnished all of the apparatus needed for the hotel equipment, including switchboards and telephones.

THE WHEELING & LAKE ERIE RAILROAD COMPANY has ordered from Allis-Chalmers Company's electrical department the Bullock Electric Manufacturing Company, of Cincinnati, equipment for its new machine and car repair shops at Canton, Ohio, consisting of two engine-type 250-volt generators, one of which is 150-kw. and the other 75-kw., and 16 motors with capacities aggregating 300 hp.

BIG SWITCHBOARD FOR WANAMAKER.—The contract for the big switchboard to be installed in the huge power plant now being constructed in Philadelphia by John Wanamaker has been allotted to J. F. Buchanan & Co., of Philadelphia. The board, with the flat copper bus-bars connecting between the dynamos and the switchboard, will cost in the neighborhood of $33,000.

EQUIPMENT FOR BARBER ASPHALT PLANT.—The Barber Asphalt Paving Company, 114 Liberty Street, New York City, has awarded a contract to Mackenzie, Quarrier & Ferguson for the equipment of a light and power plant to be installed in its Maurer, N. J., factory. The contract calls for a 240-hp Harrisburg-Fleming side crank engine, arranged for direct connection to a General Electric generator of 160 kw. capacity.

THE DETROIT UNITED RAILWAY has purchased from Allis-Chalmers Company one heavy duty cross-compound Reynolds-Corliss engine, 32 by 68, for direct connection to a 1,500-kw. generator. This will be installed in the company's station on Atwater Street, in Detroit, where it has been found necessary to provide for an extension to the existing power plant.

LIGHTING PLANT FOR TERRE HAUTE, IND.—A good-sized municipal lighting plant is to be built at Terre Haute, Ind. The capacity in the first instance will be about 1,000 hp. Mr. J. W. Wood, of St. Louis, Mo., has been retained as consulting engineer. Mr. J. F. McCulloch, of St. Louis, will be associated with Mr. Wood in the matter.

CURTIS TURBINES FOR PORTSMOUTH, N. H.—The General Electric Company has secured a contract through Sanderson & Porter for Curtis turbines to be installed in the Rockingham County Light & Power Company at Portsmouth, N. H. There will be two outfits of 500-kw. capacity each, 2,300-volt, 60-cycle, two-phase machines.

TLAXCALA HYDRO-ELECTRIC PROJECT.—A hydro-electric plant is to be constructed on the Zahuacan River, Mexico, for the purpose of generating power for lighting and general industrial use in Tlaxcala and vicinity. The local municipal authorities will operate the system. The initial equipment will be about 800 hp.

CHAPIN & GORE, of Chicago, have purchased from the Allis-Chalmers Company three Reliance engines and three generators for direct connection to same, complete with switchboard, etc., to be installed as a plant for electric light and power used in the Majestic Theatre and office building in that city.

NEW PLANT FOR SEDALIA, MO.—The United Water, Gas & Electric Company, of Sedalia, Mo., is to build a new power house to cost about $150,000. Plans regarding same are in process of preparation by Mr. Joseph McWilliams, of Louisville, Ky.

ELEVATORS FOR INTERBOROUGH ROAD.—The Marine Engine & Machine Company, of New York City, has secured a contract for electric elevators for the East Ninetieth Street and West Ninety-sixth Street substations of the Interborough Railroad system.

NATIONAL ELECTRIC ACTIVITY.—In consequence of the several large orders recently received, the National Electric Company, of Milwaukee, Wis., has increased its force of workmen at its plant.

POWER PLANT EQUIPMENTS.—The Westinghouse Electric & Manufacturing Company is building for the People's Power Company, of Moline, Ill., two engine-type generators to be installed in its power station. The company is an old one in that section of the country, and has built up an extensive business in lighting and power work. The addition to its present equipment will be an 1,100-kw, two-phase alternator of the revolving-field type, operating at 2,400 and 4,800 volts, and a 600-kw, 600-volt, direct-current machine. The alternating-current generator is a duplicate of a machine which the company put into service about a year ago. An order for three 300-kw, alternating-current generators has also been placed with the Westinghouse Company by the Barber Lumber Company, of Boise, Idaho. These machines will generate current at 440 volts, which will be transformed to 23,000 volts for transmission. The necessary transformers, switchboards and lighting arresters are included in the apparatus to be furnished.

CROCKER-WHEELER ALTERNATORS. — The Crocker-Wheeler Company has closed a contract for four 4,000-kw. water-wheel driven three-phase alternators for the Sanitary District of Chicago. These machines will be of the same type as the three 4,000-kw. alternators sold by the same company some time ago to the Gas & Electric Corporation, of San Francisco.

Financial Intelligence.

THE WEEK IN WALL STREET.—The activity in the stock market was largely manipulative, but after showing hesitation early in the week, mainly on the Interborough strike, prices developed decided strength. The local traction stocks were supported in the face of the strike, and industrial securities also exhibited strength. The United States Steel stocks receded with the rest of the list at first, but, though not specially prominent, rallied easily. Electric and traction securities were active and stronger, advances being recorded in the majority. The Allis-Chalmers issues were exceptions, the common stock closing at the lowest figure of the week—16½—and preferred at 62, which latter represents a net loss of 1½ points. General Electric and Westinghouse common closed at the highest quotations of the week, 188 for the former and 182⅜ for the latter. Confidence was not lost in Interborough Rapid Transit on account of the strike. This stock actually made a net gain of 12 points, closing at 219. Manhattan Elevated held its own and gained ¼ point, the last quotation being 171. On the other hand, Metropolitan Street Railway showed some weakness and closed at 123¼, which is a slight loss. Brooklyn Rapid Transit was fairly active, closing at 66⅝—a net gain of ⅛ point. Electric Storage Battery's last quotation was the highest for the week, viz., 87¾, and Western Union held its own, closing at 94, which is ¼ point better. The market for outside securities was generally firm, Interborough Rapid Transit being exceptionally strong after an early decline of 5 points. The copper group was firm in sympathy with the rise in copper shares on the Stock Exchange. Following are the closing quotations of March 14:

NEW YORK

	Mar. 7	Mar. 14		Mar. 7	Mar. 14
Allis-Chalmers Co	17¼	16½	Electric Vehicle pfd	21	21
Allis-Chalmers Co. pfd	63½	60½	General Electric	187½	187⅛
American Tel. & Cable	92	91	Hudson River Tel.		
American Tel. & Tel.	145	144	Interborough Rap. Tran.	206	214
American Dist. Tel	32	33	Metropolitan St. Ry.	123⅝	122½
Brooklyn Rapid Transit	66⅜	66⅝	N. Y. & N. J Tel.	172	
Commercial Cable			Marconi Tel.		
Electric Boat	39	38	Western Union Tel.	93⅞	94⅛
Electric Boat pfd.	79	79	Westinghouse com	180	181
Electric Lead Reduction	¼	¼	Westinghouse pfd	190	190
Electric Vehicle	12	12			

BOSTON

	Mar. 7	Mar. 14		Mar. 7	Mar. 14
American Tel. & Tel.	146	145¾	Western Tel. & Tel. pfd.	102	*103
Cumberland Telephone	120	121	Mexican Telephone	1⅛	1⅛
Edison Elec. Illum	250	252	New England Telephone	137	137
General Electric	187	187½	Mass. Elec. Ry	16⅛	*18⅜
Western Tel. & Tel.	20	20⅛	Mass. Elec Ry. pfd.	82	*84⅛

PHILADELPHIA

	Mar. 7	Mar. 14		Mar. 7	Mar.
American Railways	52⅛	52⅛	Phila. Traction	90¾	
Elec. Storage Battery	87	88⅛	Phila. Electric	10¼	10¼
Elec. Storage Battery pfd.			Phila. Rapid Trans.	29¾	29¾
Elec. Co. of America	12½	12			

CHICAGO

	Mar. 7	Mar. 14		Mar. 7	Mar. 14
Central Union Tel.			National Carbon pfd.	113	114
Chicago Edison			Metropolitan Elev. com.	22	22
Chicago City Ry.			Union Traction	11	*13
Chicago Tel. Co.	142		Union Traction pfd.		*51
National Carbon	44	43			

* Asked.

HUDSON RIVER TELEPHONE.—At the meeting of the stockholders of the Hudson River Telephone Company held last week the annual report submitted by the directions showed an increase in income for the 12 months of $18,890, an increase in interest charges of $27,435 and a decrease in funds remaining for dividends of $8,545. The net revenue applicable to dividends was $244,416, and the dividends paid amounted to $234,372. Additions and betterments during the year placed in the construction account aggregate $527,915. The gain in the number of telephones was 5,176. The profit an loss account for the year shows: Revenue—Exchange service $627,736; toll line service, $246,093; private line and sub-license, $12,455; real estate $22,190; dividends and interest, $587; miscellaneous, $29,298; total, $938,363. Expenses—General, $132,346; operating, $237,452; maintenance, $210,141; instrumental rental, $41,725; real estate expense, $13,086; miscellaneous, $14,869; total, $649,621. The net revenue from operation was $288,742 and interest charges, $44,325, leaving balance, $244,416. The surplus, January 1, 1904, was $341,313; less charge, on account of storm of November 13, $34,689. The surplus, December 31, 1904, was $316,668. The balance sheet shows the following assets and liabilities at the close of the year: Assets—Contracts and licenses, $601,352; construction, $4,361,297; supply department, $68,555; real estate, $287,373; stocks and bonds, $10,000; accounts receivable, $153,697; cash, $27,344; total, $5,509,620. Liabilities—Capital stock, $3,906,200; surplus, $316,668; debt, $1,224,882; reserve, $3,275; reserve dividend payable January 16, 1905, $58,593; total, $5,509,620.

BALTIMORE ELECTRIC POWER.—The issue of $7,500,000 of 5 per cent. bonds of the Baltimore Electric Power Company, of which the Northern Trust Company, of Philadelphia, is trustee, is applied as follows: To build new plant, $2,245,000; to retire first mortgage bonds of Maryland Telephone Company, $1,000,000; to retire general mortgage bonds of Maryland Telephone Company, $1,155,000; to retire ground rent on Maryland Telephone Building, $100,000; for future extensions of electric power and telephone plants, $3,000,000; total, $7,500,000. The immediate issue of bonds has been underwritten by the Northern Trust Company, of Philadelphia, and the Central Trust Company, of Baltimore. These companies have sub-syndicated the whole issue to institutions and capitalists in Philadelphia, Pittsburg, New York and Baltimore. The holders of a majority of the general mortgage bonds of the Maryland Telephone Company have agreed to exchange them for bonds in the new company, and this issue will be retired. The first mortgage bonds of the Maryland Telephone Company can be called in and retired at 105.

BELL TELEPHONE BONDS.—The American Telephone & Telegraph Company received bids for $25,000,000 4 per cent. collateral trust bonds, due in 1929. The bonds were awarded to Kidder, Peabody & Company and Baring Bros. Within the last three months subsidiary Bell Telephone companies have authorized new stock issues as follows:

Bell Telephone Company, Buffalo	$550,000
Cumberland Telephone	1,754,300
City & Suburban (Cincinnati)	1,000,000
Southern New England	5,000,000
Total	8,304,300

The Southern New England issue has not yet been made, but the company has petitioned to have its stock increased from $5,000,000 to $10,000,000.

BELL TELEPHONE EARNINGS.—A forecast of the American Telephone and Telegraph Company's forthcoming annual report gives the net earnings, after taxes are paid, as $13,435,562. The surplus, after interest on bonds and notes and payment of dividends will be about $9,799,117. The increase in net earnings for the year was $1,350,000 while the increase in charges and dividends was $1,819,000, resulting in a decrease in surplus of $468,000.

EVERETT-MOORE TRUSTEESHIP.—It is stated that a dissolution of the Everett-Moore trusteeship has been practically effected and the corporation is on a private basis again. The company is now controlled by the large banks of Cleveland, Ohio, although the properties are still being operated by the men in charge at the time the company collapsed.

JAPANESE TROLLEY FINANCES.—The *Nichi Nichi Shimbun* reports that the Tokio Street Railway Company has obtained a loan of $1,500,000 from the Sun Insurance Office of Canada, for a short period. The money was obtained at 5½ per cent., out of which one-half per cent. went to the indorsers, the Yasuda and Kogyo banks.

NEW ORLEANS RAILWAY.—The New York Trust Company announces that 94 per cent. of the bonds, 93½ per cent. of the preferred stock, and 97 per cent. of the common stock have been actually deposited under the plan of reorganization of the New Orleans Railway Company.

DIVIDENDS.—The Western Union Telegraph Company has declared the regular quarterly dividend of 1¼ per cent., payable April 15; reopen, April 1. International Steam Pump directors have declared the regular quarterly dividend of one-half of 1 per cent. on its common stock, payable April 1.

PLATT BOND MORTGAGE.—The Platt Iron Works Company, of Dayton, Ohio (successors to the Stilwell-Bierce & Smith-Vaile Company), has given a mortgage to the Cincinnati Trust Company in order to secure $800,000 bonds.

ELECTRICAL EARNINGS.—Messrs. Stone & Webster report the earnings of the following companies for the month of December, 1904:

Edison Electric Illuminating, of Brockton:

	1904.	1903.	Changes.	
December gross	$14,433	$11,746	Inc.	$2,687
December net	6,013	5,682	Inc.	331
December surplus	5,320	4,325	Inc.	995
Jacksonville Electric Co.:				
December gross	$26,566	$21,424	Inc.	$5,142
December net	11,501	5,817	Inc.	5,684
December surplus	8,485	2,648	Inc.	5,837
Lowell Electric Light Corporation:				
December gross	$25,553	$23,993	Inc.	$1,560
December net	12,987	10,612	Inc.	2,375
December surplus	11,832	9,122	Inc.	2,710
Savannah Electric Company:				
December gross	$48,453	$45,143	Inc.	$3,310
December net	15,599	21,163	Dec.	5,564
December surplus	5,046	10,708	Dec.	5,662
Houghton County Electric Light Company:				
December gross	$23,592	$22,987	Inc.	$605
December net	13,837	13,374	Inc.	463
December surplus	11,649	11,136	Inc.	513
Houghton County St. Ry. Co.:				
December gross	$17,079	$13,756	Inc.	$3,323
December net	3,586	1,748	Inc.	1,838
December surplus	†253	949	Inc.	1,202
†Deficit.				
Minn. Electric Co.:				
December gross	$77,512	$65,491	Inc.	$12,021
December net	45,771	36,814	Inc.	8,957
December surplus	36,626	26,528	Inc.	10,098
Tampa Electric Co.:				
December gross	$33,653	$26,883	Inc.	$6,770
December net	12,892	7,878	Inc.	5,014
December surplus	10,990	6,078	Inc.	4,912
Terre Haute Traction & Light Co.:				
December gross	$52,070	$45,524	Inc.	$6,546
December net	19,560	11,119	Inc.	8,441
December surplus	10,338	1,638	Inc.	8,700
Seattle Electric Co.:				
December gross	$208,727	$193,592	Inc.	$15,135
December net	58,227	66,464	Dec.	8,237
December surplus	32,907	50,117	Dec.	17,210

CUMBERLAND TELEPHONE.—The Cumberland Telephone & Telegraph Company has issued its annual report for the year ended December 31, 1904. The income account compares as follows:

	1904.	1903.	1902.
Gross	$4,027,117	$3,480,042	$3,070,163
Expenses	2,585,807	2,170,919	2,068,184
Net	$1,441,310	$1,309,123	$1,001,979
Interest and taxes	267,142	269,031	219,814
Surplus	$1,174,168	$1,040,092	$782,165
Dividends	818,675	766,382	623,203
Surplus	$355,493	$273,710	$158,962

The earnings and expenses in detail follow:

	1904.	1903.	1902.
Gross:			
Exchange service	$2,718,592	$2,401,305	$2,205,082
Tolls	1,174,743	969,133	796,778
Private lines	1,504	1,318	3,684
Real estate	44,249	29,592	24,104
Other sources	88,029	78,694	40,515
Total	$4,027,117	$3,480,042	$3,070,163
Expenses:			
General	$325,982	$307,597	$254,479
Operating expenses	828,630	697,442	578,111
Maintenance, reconstruction, etc.	1,425,477	1,159,145	1,225,266
Real estate and miscellaneous	5,719	6,735	10,328
Total	$2,585,807	$2,170,919	$2,068,184

WESTERN UNION REPORT.—The report of the earnings of the Western Union Telegraph Company for the quarter ended March 31 shows estimated net earnings of $1,600,000, a decrease of $137,426 over the corresponding quarter of last year, and an estimated balance after payment of interest of $1,300,000, a decrease of $144,876 over last year's figures. Dividend requirements amount to $1,217,021, leaving a surplus of $82,879, as against $227,859 for the same period of 1904. On the basis of estimate the results for the nine months ended March 31 show:

	*1905.	1904.	Increase.
Net earnings	$5,540,971	$6,084,682	†$543,711
Interest on bonds	895,100	865,150	29,950
Balance	$4,645,871	$5,219,532	†*573,661
Dividends	3,651,062	3,651,051	11
Surplus	$994,809	$1,568,481	†$573,672
Previous surplus	14,881,427	13,019,724	1,861,703
Total surplus	$15,876,236	$14,588,205	$1,288,031

*Estimated. †Decrease.

UNITED POWER & TRANSPORTATION.—At the annual meeting of the United Power & Tranportation Company, held last week at Camden, N. J., the old board of directors was re-elected. The annual report of the company for the fiscal year ended December 31 compares as follows:

	1904.	1903.
Income from securities and loans	$708,512	$747,023
Expenses, taxes, fixed charges, etc.	364,056	364,448
Balance for dividends	$344,456	$382,575
Dividends	343,562	382,375
Surplus	$894	$200
Total surplus	$267,078	$266,185

TELEPHONY IN THE ROCKIES.—Subjoined is some interesting data as to the rapid development of telephony at the hands of the Rocky Mountain Bell Telephone, controlled by the American Telephone & Telegraph Company, with headquarters at Salt Lake City. The following figures show the growth of the company from 1898 to 1904:

Year.	Subscribers.	Stk. issued.	Gross. earn.	Divs.
1898	3,428	$483,650	$276,254	6%
1899	4,200	842,000	333,351	6%
1900	5,473	1,200,000	404,826	6%
1901	9,105	1,600,000	522,984	6%
1902	13,711	2,200,000	707,073	6%
1903	18,995	2,253,400	863,144	6%
1904	24,757	2,264,800	1,043,410	6%

In six years the number of subscribers has increased seven-fold; the capital stock has increased nearly five-fold; and gross earnings have increased about four-fold. The rate of dividends has been maintained at 6 per cent. A feature of the growth of the company is its increased ratio of operating expenses to gross earnings. In 1898 the ratio was .71 per cent., which is about the average for Bell telephone companies; in 1904 it had increased to 83 per cent., chiefly on account of more liberal maintenance charges. This ratio compares with about 50 per cent. for independent telephone companies, showing the conservatism of the Bell companies with respect to maintenance and depreciation. The company is rapidly extending its lines in every direction.

THE GAS & ELECTRIC DEVELOPMENT COMPANY has been organized, with offices at 1328 Chestnut Street, Philadelphia, and 82 Beaver Street, New York. The business of the company includes the following: To act as broker in the purchase and sale of electric light and power plants, electric railway, water works and gas plants; to make examinations and furnish reports on the physical and financial condition of such properties; to act as consulting engineer in connection with the construction, repair and extension of properties of this kind; to undertake the operation and management of such properties under special agreement. The officers of the company are president, Mr. Harry C. Case; vice-president and engineer, Mr. A. B. Beadle; secretary and treasurer, Mr. W. W. Levering. All of these gentlemen have had a wide experience in connection with the operation and management and sale of public service properties.

CINCINNATI BELL TELEPHONE.—An active movement in Cincinnati Bell and Suburban Telephone stock began recently when it became known that the directors had ordered that the new issue of stock be apportioned among present stockholders at the rate of one share of the new stock at par for six shares of the old. The capitalization of the Telephone Company was recently increased from $4,000,000 to $5,000,000, in order to take in a number of outlying companies. Last summer the stock touched its lowest point, at 141. It has risen steadily in the public estimation, however ,and lately has been very closely held at 159 and 160. Last week the first movement noted carried the price to 161 and 162, with few sales recorded even at this figure.

LONG IOWA ELECTRIC ROAD.—The Iowa and Illinois Railway, an electric road, organized with a steam charter and running between Davenport and Clinton, Iowa, is nearly completed, and is being operated. The road runs a distance of thirty-six miles, and has traffic agreements for passengers to Rock Island and Moline, Ill. The cost of building the road was about $1,260,000. It has bonds outstanding which amount to $1,050,000, which the contractors will offer as soon as the full service of the road is in operation. The bonds are twenty-year five per cent. first mortgage gold bonds, dated January 1, 1904, and due January 1, 1924. Of the total issue of $2,000,000 bonds, $950,000 are retained in the treasury. Of the authorized $1,575,000 in stock $1,500,000 is outstanding.

TELEPHONY IN PITTSBURG.—The Central District & Printing Telegraph Company, of Pittsburg, (Bell telephone), reports as follows for the year ending December 31:

	1904.	1903.
Gross	$3,055,433	$2,733,926
Net	900,544	742,083
Dividends	800,000	700,000
Surplus	100,544	42,083

LIGHTING IN ILLINOIS.—According to Springfield, Ill., dispatches incorporation papers have been asked for by the Western Gas Light and Electric Company of America; capital, $7,000,000, the company being a consolidation of plants in the suburban towns of Chicago.

CONSOLIDATION AT WHEELING.—A merger of the city and suburban traction companies of Wheeling, W. Va., with the electric light, water and bridge concerns has been completed. A corporation capitalized at $7,000,000 will control all the companies in the organization.

General News of the Week

The Telephone.

BIRMINGHAM, ALA.—The Lawrence County Telephone & Telegraph Company, capital stock $3000, has been formed. Incorporators: F. L. Woodruff, R. L. Quinn, J. D. Andrews and D. I. Carson.

TUSCUMBIA, ALA.—The Southern Bell Telephone Company is adding several thousand feet of aerial cable to its lines connecting Tuscumbia, Sheffield and Florence. This equipment will enable the company to put in over a hundred new telephones.

LOS ANGELES, CAL.—The Southwestern Home Telephone Company, with headquarters at Redlands, has been incorporated, to build a telephone system to desert towns, to Alessandro and San Jacinto Valleys and to many other important points in the Southwest. The incorporators are K. C. Wells, A. Gregory, C. H. Bigelow, J. F. Dostal, R. J. Dunn, J. W. Lamb, Redlands; J. L. Shirbley, Banning.

LOS ANGELES, CAL.—C. W. Hinchcliffe, general manager of the Consolidated Telephone, Telegraph & Electric Company, with headquarters in Tucson, Ariz., has announced the details of an enterprise large enough to bind all the western cities together by telephone communication. A line will be built from Los Angeles 806 miles to El Paso and then northeast 278 miles to Denver. Another line will be built from a point in California to Yuma, Phœnix, Tucson, Benson and Bowie. From the other end the men will work from El Paso, Deming and on through New Mexico. Branch lines will extend up into the Tonto Basin, where the large government dam is being built. Another line will go down into Cananea, Mexico. The Sunset Telephone & Telegraph Company will connect with the Consolidated system. Copper wire weighing 870 pounds to the mile will be used.

GOLCONDA, ILL.—The Pope County Telephone Company has increased its capital from $5000 to $15,000.

CARTHAGE, ILL.—The Mississippi Valley Telephone Company has increased its capital from $25,000 to $50,000.

BRUCE, ILL.—The Bruce Mutual Telephone Company has been incorporated with a capital of $2500. C. H. Luterell is one of the incorporators.

ELROY, ILL.—Charles W. Heath has been granted a ten-year franchise for a telephone exchange in Kendall and expects to have it in operation in a few months.

MARIGOLD, ILL.—Lemuel Mudd, of this place, is the promoter of a new telephone company which will probably be named the Marigold-Detering Telephone Company.

FLORA, ILL.—A mutual telephone system has been organized by the farmers in the Golden Neighborhood. Connections will be made with the Friend Telephone system in Flora.

CHICAGO, ILL.—The increase in the number of telephones installed by the Chicago Telephone Company during February was 1664. The total number of instruments now in service, city and country, is 121,233.

NASHVILLE, ILL.—The Central Union Telephone Company, licensee of the American Telephone & Telegraph Company in Illinois has purchased the entire holdings of the independent company in this (Washington) county. The transfer includes Nashville and Okawville exchanges and all toll lines.

LAPORTE, IND.—The Laporte Telephone Company, of which J. Vene is president, has increased its capital from $30,000 to $60,000.

PRINCETON, IND.—The Cumberland Telephone & Telegraph Company is preparing to erect an office and exchange building in this city this spring.

RICHMOND, IND.—The Central Union Telephone Company has asked permission to construct electric underground conduits in the business section of the city.

GREENTOWN, IND.—The Greentown Telephone Company has incorporated with a capital stock of $30,000. J. M. Glenn, W. L. Bott and A. A. Largent are the directors.

TIPTON, IND.—The Fairview Co-operative Telephone Company has been incorporated with a capital of $1025. The incorporators are W. H. Achenbach, L. H. Houll and others.

CAMDEN, IND.—The Camden Co-operative Telephone Company has decided to construct three new lines to different sections. The company will be in the market for wire and other material.

FT. RITNER, IND.—The Ft. Ritner Telephone Company has incorporated with a capital stock of $1486. The directors are E. E. Wicker, W. A. Holland, Thos. J. Field, L. G. Boyd and E. B. Dixon.

WEST TERRE HAUTE, IND.—The Farmers' & Mechanics' Mutual Telephone Company has been organized and incorporated here. The capital stock is $5000. Directors: W. F. Tippin, Jas. H. Davis, M. T. Goodman, Jno. E. Gamson and Edgar Philabaum.

DECATUR, IND.—The Citizens' Telephone Company has bought the Nichols block on Monroe Street which will be remodelled for the company's exchange and offices. The Citizens' Company is one of the strongest and most progressive independent companies in the State and when established in its new home will furnish a service second to none of its class.

INDIANAPOLIS, IND.—The New Long-Distance Telephone Company has issued a new map which shows all the lines owned by the company besides the connecting toll lines and the county toll lines which are operated in connection with the long-distance lines. The New Long Distance Company owns 10,000 miles of wire, there are 12,000 miles of wire subject to its use by the connecting lines, besides 8000 miles of county toll lines. The independent telephone lines have 368 exchanges, 1560 toll offices, 30,000 miles of toll line wire and 166,255 telephone subscribers. The map is printed in colors and shows all the stations that can be reached over the system. It also contains other interesting data such as the population of the county and the number of telephones in each county. Every county in the state is covered and 2,516,462 people can communicate by reason of this great network of lines and the 166,255 telephones in use by this toll line system.

ALVORD, IA.—Another farmers' telephone line will be built from here to Inwood.

MILFORD, IA.—On March 27 the town will vote on a franchise to the Midland Telephone Company.

DES MOINES, IA.—The Sabuta Telephone Company, capital $3000, has been incorporated by A. T. Chafer and others.

CALUMET, IA.—The Calumet Telephone Company has been formed, capital $1000. President, Lewis Head; secretary, George Shafer.

PLAINFIELD, IA.—The Bremer & Butler Mutual Telephone Company has been formed, capital $10,000. President, Charles Colburn; secretary, William Suram.

BLOOMFIELD, IA.—The Mid-Western Electric Company, of Cedar Rapids, has purchased the Davis County telephone system of W. J. Steckel. The consideration of the sale was $37,000.

DES MOINES, IA.—The Lincoln Telephone Company has filed articles of incorporation with the Secretary of State. Capital $6900. Jacob Jacobson is president and Ole Sandersen, secretary.

CHARLES CITY, IA.—The Farmers' Mutual Telephone Company, of Charles City, has been formed. The authorized capital stock of the company is $20,000. The incorporators of the new company are M. A. Hirsch, J. D. Vornes, B. E. Hand, F. T. Stromberg and William Braend.

BROWNELL, KAN.—The Pleasant Plain Telephone Company has been formed, capital $1000.

MINNEAPOLIS, KAN.—The Rural Telephone Company, of this city, has been formed, with a capital of $6000.

LOUISVILLE, KY.—The New Home Rural Telephone Company has filed articles of incorporation with a capital stock of $270.

BARBOURVILLE, KY.—John Woodward has organized a company to be known as the Cumberland River Telephone Company, and will begin at once to construct lines from Barbourville, Ky., to Keely, Tenn., via Williamsburg. Material for lines has already been bought, and the company will be incorporated at once with a capital stock of $5000. John Woodward will be president and general manager, and L. R. Benjamin, of Barbourville, secretary and treasurer.

RIVERHEAD, L. I.—The officers of the Baiting Hollow & Roanoke Telephone Company, the North Shore Telephone Company, of Port Jefferson, and the Suffolk County Telephone Company, of Patchogue, have reached an agreement to connect the lines of all three companies. The connection will be made at Wading River and it is thought that the lines will be ready for the new service inside of three months.

NEW ORLEANS, LA.—There is a movement among leading business men to establish an independent telephone system in this city. The company is to have a capital of $1,000,000. No names of the promoters are given.

GREENVILLE, ME.—The Greenville & Kennebec Telephone & Telegraph Company has been incorporated with a capital of $10,000, by C. D. Shaw and H. A. Shaw.

CUMBERLAND, MD.—The Long Distance Telephone Company's line between this city and Baltimore has been opened for business.

RIDGELEY, MD.—J. Frank Booth, of Denton, Md., and associates, contemplate organizing a company to build and operate a telephone line from Ridgeley to Hilsboro and return, a distance of 30 miles.

ADRIAN, MICH.—The Evans' Lake Telephone Company has disbanded, and in its place a new company has been formed, to be known as the Franklin-Cambridge line. The newly-elected officers are as follows: President, Burk Rynd; secretary, P. B. Aten; treasurer, Fred Welch.

GRAND MEADOW, MINN.—A new telephone company has been organized with a capital of $50,000. C. F. Greening is secretary.

HECTOR, MINN.—The Hector Telephone Exchange has been incorporated by Emil Larson, E. Dahlgren and others. The capital stock is $25,000.

MORA, MINN.—The Farmers' Springbrook Telephone Company has been organized with J. C. F. Long, president, and Howard Aldrich, secretary.

PIPESTONE, MINN.—The Southern Minnesota Telephone Company, whose headquarters are at Pipestone, has sold its system to the Dakota Central Telephone Company.

MINNEAPOLIS, MINN.—Plans are under way for the organization of a new company to build a direct telegraph line between Minneapolis and Winnipeg. Local officers of the North American Telegraph Company are the promoters, so that it is indirectly a Postal Telegraph-Cable plan.

ST. PAUL, MINN.—Joint telephone service between competing and connecting lines is required by a bill introduced in the Legislature. The bill requires companies operating lines to allow such joint connection for reasonable compensation, messages to be paid for at the usual rate, and the cost of installing the connection to be borne by the company requesting the joint service. Failure to allow such joint connections and joint service is punishable by revocation of the company's charter and enjoining it from any and all rights

to transact a telephone business, and by a forfeiture to the person requesting such joint connections of $25 to $100 a day for each day after neglect or refusal to allow joint service.

MERIDIAN, MISS.—I. L. Wetsel, F. E. Gressett, W. N. Ethridge, S. A. Jones, C. B. Lusk and others have incorporated the Meridian Home Telephone Company with $250,000 capital stock.

OMAHA, NEB.—The Nebraska Telephone Company will erect a branch exchange building at 33d and Harney streets.

AMELIA, NEB.—The South Fork Independent Telephone Company, of Amelia, Holt County, has been incorporated with a capital stock of $2000.

NEWARK, N. J.—The Citizens' Union Telephone Company has been incorporated with a capital stock of $150,000. The incorporators are Lester Park, Red Bank; Edgar W. Danner, New York, and Henry C. Beach, Newark.

ALBANY, N. Y.—The Hudson River Telephone Company will expend about $25,000 to improve its service in Rensselaer. A new building will be erected.

POTSDAM, N. Y.—The Robinson Telephone Company has been chartered, capital stock $10,000. Incorporated by L. T. Robinson, Potsdam, and L. I. Robinson, Crary's Mills, N. Y.

WATERVILLE, N. Y.—The Waterville Telephone Company has been incorporated with a capital stock of $25,000. The directors are I. D. Brainerd, M. W. Terry and S. W. Goodwin, Waterville.

NEW YORK, N. Y.—It is announced that after April 1 the telephone rate to all boroughs in the city, on calls from public telephones, will be 10 cents. There will also be a reduction in charges to subscribers. The Merchants' Association is informed that there will be no legislative investigation of telephone charges in the city.

ALBANY, N. Y.—The Savannah Telephone Company, of Savannah, Wayne County, has been incorporated to construct lines connecting Savannah, Clyde, Port Byron, Wolcott, Red Creek, Seneca Falls, Cato and other points in Wayne, Cayuga and Seneca counties. The company is capitalized at $4000 and the directors are Charles A. Mead, Crossman A. Coleman, Fred W. Hadden and Edson S. Wood, of Savannah; Marcus S. Fowler, of Butler, and George P. Vandewater, of Spring Lake.

OTSEGO, N. Y.—The consolidation of the Otsego County independent telephone systems takes in the Cooperstown Telephone Company, Richfield Springs Telephone Company, Hartwick Telephone Company, Butternut Valley Company, and the Otsego Telephone & Toll Line Company. The combination is to be known as the Otsego Home Telephone Company, has an authorized capital stock of $40,000 and authorized bond issue of $150,000, contains the exchanges of Cooperstown, Richfield Springs, Hartwick and Morris, 1000 telephones, 150 miles of toll line, and reaches all the principal places in Otsego County. The directors are Dr. H. A. Harrison, Utica; John A. Losie, Richfield Springs; George Whitman, Morris; M. E. Lippet, Cooperstown; H. O. Bench, Hartwick; F. C. Ward, Richfield Springs, and T. H. Ferris, Utica. They have selected these officers: President, Dr. Harrison; vice-president, George Whitman; secretary, John A. Losie; treasurer, T. H. Ferris; manager, C. H. Poole.

GUYSVILLE, OHIO.—The Guysville Telephone Company has increased its capital stock from $3000 to $6000.

COLUMBUS, OHIO.—The Toledo Home Telephone Company has been granted a franchise to enter this city.

COSHOCTON, OHIO.—The Coshocton County Telephone Company has been incorporated with a capital of $30,000. The incorporators are J. Q. Finlay, J. L. Beck and others.

WARREN, OHIO.—The Mesopotamia Telephone Company has been organized as follows: President, H. J. Wilcox; vice-president, T. W. Kingdon; secretary, J. A. Sealey; treasurer, Warren Bates.

COLUMBUS, OHIO.—The Cincinnati & Suburban Bell Telephone Company, Cincinnati, has filed a certificate with the Secretary of State increasing its capital stock from $4,000,000 to $5,000,000.

BUCYRUS, OHIO.—The Bucyrus Telephone Company has decided to replace the apparatus at the central office in this city with entirely new equipment and has let the contract to the American Electric Telephone Company of Chicago.

LEAVITTSBURG, OHIO.—At a meeting of the new board of directors of the Leavittsburg and Phalanx Telephone Company R. F. Templeton was elected president; J. L. McConnell, vice-president; E. E. Higley, secretary and treasurer and B. F. Ives, general manager.

URBANA, OHIO.—The subscribers of the Urbana Telephone Company have been notified that the company has decided to advance the rental of telephones 25 per cent. over the present rate. This applies only to residence telephones, however, as they are the greatest in number and cheapest in price.

PERRYSBURG, OHIO.—The Maumee Valley Telephone Company's report makes a good showing. It is a Bell sub-licensee. The report of the general manager showed the company to be in a very prosperous condition. Over 130 subscribers were added during the past year. Twenty-six miles of cedar pole lines were built on which was placed over 100 miles of wire. The company expects to do a considerable amount of new work the coming season. The new board of directors is Jacob Davis, A. C. Fuller, Ed. L. Blue, William Comstock, G. W. Hoffman, Chas. L. Koch, W. C. Perrin, Norman L. Hanson, R. R. Hillard, C. L. Maddy, George Limmer, Thos. M. Franey, T. H. Tinney, A. J. Witzler and E. A. Underhill. The officers are: President, Jacob Davis; vice-president, C. F. Hoffman; treasurer, R. R. Hartshorn; secretary and general manager, R. R. Hillard.

WAYNOKA, OKLA.—The Waynoka Telephone Company has been formed with a capital stock of $500. The incorporators are J. A. Green, J. F. Sranan, G. P. Chestnut, R. A. Hendrie, E. P. Clapper and D. P. McNally.

OREGON CITY, ORE.—The Estacada Telephone & Telegraph Company has been incorporated with a capital stock of $10,000 by M. C. Adkins, R. O. Boswell, J. B. Haviland, J. W. Reed and R. A. Stratton. It will build an independent system in Clackamas County.

WILLIAMSPORT, PA.—The United Telephone & Telegraph Company will construct a branch line from Benton to Waller, and then to Derris. A private company will be formed.

CHEST SPRINGS, PA.—A farmers' telephone company has been organized for the purpose of constructing a telephone line from Chest Springs to Bradley Junction. At Chest Springs the line will be connected with the Cambria Telephone company's lines. Officers have been elected as follows: President, Dr. Somerville; vice-president, Edward Boes; secretary and treasurer, James A. Farabaugh.

PITTSBURG, PA.—The Pittsburg & Allegheny Telephone Company is just completing the installation of one of the largest private branch exchange systems ever ordered from any telephone company. The Carnegie Company has adopted the P. & A. exclusively for its private exchange system, and now has in operation nine exchanges with almost a thousand telephones. There are about 100 telephones in the Carnegie building on Fifth Avenue, with trunk lines and branch exchanges at Homestead, Duquesne, Braddock, the Edgar Thomson Works, South Sharon, Youngstown, etc.

PROVIDENCE, R. I.—The Providence Telephone Company has been chartered with a capital of $5,000,000. Dexter B. Potter is president.

ABERDEEN, S. D.—The Dakota Central Telephone Company will extend its lines from Gettysburg to Pierre.

EUREKA, S. D.—Farmers of McPherson and Edmunds counties have organized a telephone company under the name of the Edmunds County Mutual Telephone Company. A. Hoffman is president and F. Blakeman, treasurer.

GRAPEVINE, TEX.—The Grapevine Telephone Company has been incorporated by J. E. Raust, A. L. Winfrey and others. The capital stock is $2500.

GRANGER, TEX.—Messrs. Charles Wilson, H. C. Cooke and A. R. Lawrence, of this city, have purchased the telephone exchange here from R. H. Bradley, of Holland.

ORANGE, TEX.—The following-named officers have been elected for the Orange Telephone Company: President, E. L. Bruce; vice-president, A. R. Webber; manager, E. R. Webber.

ORANGE, TEX.—The Orange & Newton Telephone Company has been organized with principal office at Orange. The company has a capital stock of $5000. E. R. Webber is interested.

AUSTIN, TEX.—The telephone and electric light and street railway companies operating in Texas are much disturbed over the taxation legislation now pending in the Texas legislature. One bill places a tax of 1 per cent. on the gross receipts of all street railway companies, 1½ per cent. on the gross receipts of all telephone companies and ½ of 1 per cent. on the gross receipts of all electric light companies. An intangible assets tax bill which applies to street railway and electric light companies is also pending. Both of these measures have passed the House and are now before the Senate committee on internal improvements.

SALT LAKE CITY, UTAH.—The financial statement of the Rocky Mountain Bell Telephone Company for 1904, embracing Utah, Montana, Idaho and Wyoming shows net earnings for the year amounting to $171,761.09. The directors elected were George Y. Wallace, H. C. Hill, George M. Downey, Thomas Marshall, James Ivers, W. W. Riter and W. S. McCornick, all of Salt Lake City; F. P. Fish, Boston, Mass., and B. F. White, of Dillon, Mont.

CAMBRIA, WIS.—The Farmers' Mutual Telephone exchange has been incorporated.

RIVER FALLS, WIS.—A. F. Morgan has been granted a franchise for a telephone exchange here.

REESEBURG, WIS.—The Reeseburg Mutual Telephone Company has been organized. The new company has been incorporated by Martin V. Garner, J. C. Moody and A. L. Mortimer.

REESEVILLE, WIS.—The Dodge County Telephone Company has been incorporated here with a capital of $975. The incorporators are Chris Rheinhard, F. H. and Wm. Dauffenbach and others.

ZAPOTLAN, STATE OF JALISCO, MEX.—Esteban Arreola will install a telephone system at Zapotlan.

DELARDENA, MEX.—The Mexico-American Mining & Developing Company will build a telephone system to connect the company's smelter with its different mines. Phil Head, of Torreon, will have charge of the work.

CULIACAN, MEX.—The Government of the State of Sinaloa will construct a telephone line between Culiacan and the port of Mazatlan. It has also decided to extend the state system of telephone lines to a number of towns in the northern part of the state. Governor Canedo, of Culiacan, can give information.

CITY OF MEXICO, MEX.—T. F. Maguire, general manager of the Mexican Telephone Company, recently made a trip of inspection of the company's exchanges at Monterey, Tampico, Progreso and Merida and other towns. He says that these places will soon have modern telephone systems. Many improvements will be made and all will be planned for a period of twenty years. A new switchboard is being installed at Monterey. The Monterey exchange now has about 900 subscribers. About 30,000 feet of new cable is also to be installed at Monterey.

SALTILLO, MEX.—Mr. Juan Woessner, who is building an extensive long-distance telephone system in Northern Mexico, states that he will extend the line from San Pedro to Monterey, a distance of about 160 miles. He says that he will also build the line from Monterey south to Saltillo, a distance of 70 miles. He now has about 400 telephones in use in Torreon, Gomez Palacio, Lordo and upon the ranches of that section. It is Mr. Woessner's intention to build long-distance telephone lines from Torreon to Matamoras, and to Mapimi. The concession from the Mexican Government authorizes him to install telephone exchanges and build long-distance lines anywhere in the states of Coahuila, Nuevo Leon and Durango.

MONTREAL, QUE.—At the annual meeting of the Bell Telephone Company, held at Montreal, Mr. C. F. Sise, the president, stated that the company could spend as much as $2,000,000 per year in extensions and improvements, so rapidly was the system growing, but was now within two millions of the total capital it was allowed to issue by its charter. To secure the right to issue additional capital, application would have to be made to Dominion Parliament, and he feared that such an application would meet with very strong opposition. Twenty-five years ago the company began business with a capital of $397,000. To-day the capital is $8,000,000 in stock and a bond issue of $2,000,000. In

Electric Light and Power.

JACKSON, ALA.—Mr. George F. Brookman has completed an electric lighting plant for this town.

SAN FRANCISCO, CAL.—The Oro Water, Light & Power Company has been incorporated, with a capital of $3,500,000, by J. A. Kretchmar and J. Alexander, of San Francisco, and R. C. Medcraft and L. A. Redman, of Alameda.

EMPIRE, COLO.—W. P. Clough, of Denver, president of the Clear Creek County Power & Irrigation Company, writes that it is proposed to construct a power plant at a cost of about $75,000. Contracts will probably be let about May 1. H. R. Oliver, of Georgetown, Col., is the engineer.

NEW LONDON, CONN.—The Eastern Connecticut Electric Power Company has applied to the Legislature for additional powers. The concern seeks authority to operate in various additional towns in New London County. It asks authority to manufacture and distribute electricity in the towns of Lebanon, Bozrah, Preston, Griswold, Voluntown, North Stonington, Ledyard, Montville, Salem, Colchester and Norwich.

WASHINGTON, D. C.—Bids will be received March 21 at the Bureau of Supplies and Accounts, Navy Department, Washington, for furnishing the navy yards at Portsmouth, N. H.; Boston, Mass.; Newport, R. I.; New York, N. Y.; League Island, Pa.; Annapolis, Md.; Washington, D. C.; Norfolk, Va., and Pensacola, Fla., a quantity of electric cable, broken stone, piles, electrical and other supplies. Address H. T. B. Harris, Paymaster-General, U. S. N.

JACKSONVILLE, FLA.—The electric light plant of this city was recently damaged by the explosion of one of the boilers. The fireman, a negro, was killed, and the engineer fatally injured. The property damage amounted to about $3000.

COVINGTON, GA.—It is reported that the City Council is arranging to re-establish the city electric light plant.

MOUNTAINHOME, IDA.—The management of the Mountainhome Light & Transit Company announces that its power plant will be established at Crane Falls on the Snake River, and that on its completion work will be commenced on an electric railroad.

BLOOMINGTON, ILL.—The City Council has granted C. A. Griffin, S. R. White and P. R. Longworth an electric light franchise.

CHARLESTON, ILL.—The Charleston Illuminating Company has been organized to furnish light, heat and power.

GALESBURG, ILL.—Bids will be received March 20 by the city clerk for furnishing material and erecting a power house and stack for the Board of Education. J. Grant Beadle, Galesburg, is the architect.

DANVILLE, ILL.—The Danville Street Railway & Light Company is preparing to expend $50,000 in improving its lighting system at Danville. Mr. McKinley, the president of the company, has in contemplation improvement of his plant at Decatur, including the installation of new boilers.

EAST ST. LOUIS, ILL.—The Illinois Illuminating Company, which withdrew its request for a franchise in East St. Louis several months ago, has made another request for the same franchise. An offer is made to deposit $25,000 in East St. Louis, St. Louis or United States bonds for the fulfillment of a contract to carry out all suggestions made in the franchise, but not to build a plant in East St. Louis.

TERRE HAUTE, IND.—J. W. Wood, St. Louis, Mo., has been engaged as consulting engineer for the erection of a municipal electric light plant at Terre Haute, Ind. J. F. McCullough, 208 Security Building, St. Louis, will attend to the electrical part of the contract.

LAFAYETTE, IND.—Isham Randolph, engineer of the Sanitary District of Chicago, Ill., in his report to the Business Men of Lafayette, interested in the project of building a dam across Wabash River for the generation of power, estimates the total cost of the dam, hydraulic and electrical equipment at $248,000.

MADILL, I. T.—W. F. Porter has obtained a franchise from the City Council of Madill to install an electric light and power plant here.

MUSKOGEE, I. T.—The Muskogee Electric Light & Ice Plant was turned over March 1, to the Muskogee Ice & Power Company, and will be operated by it under lease. The plant is owned by Belleville, Ill., capitalists.

SOUTH MACALESTER, I. T.—The Choctaw Electric Company was incorporated March 9, with a capital stock of $150,000. The officers are: A. E. Pierce, president; C. G. Wehrley, vice-president; M. M. Lindley, secretary; A. W. Thomas, treasurer. The charter provides that the company may engage in a light and general electric business.

OTTUMWA, IA.—The Ottumwa Traction & Light Company proposes to build a power house during this season and increase the equipment of boilers, engines and generators.

CENTERVILLE, IA.—The Home Electric Company and the Mutual Electric Company, both of Centerville, have petitioned for franchises. The citizens will, on March 27, vote on the question of granting a franchise.

JEWELL CITY, KAN.—A. G. Blankenshy writes that bids will be received May 15 for constructing an electric light plant, to cost $2000.

JUNCTION CITY, KAN.—It is stated that the Republican River Hydraulic Power Company is preparing to construct a dam here for electrical purposes.

WAVERLY, KAN.—W. K. Palmer, Kansas City, Mo., has secured the contract for engineering services in connection with the municipal electric light plant about to be constructel.

ANTHONY, KAN.—W. K. Palmer, Kansas City, Mo., has been engaged as engineer in connection with the construction of a municipal electric light plant. Plans and specifications are now being prepared.

LAWRENCE, KAN.—It is stated that there is a movement on foot here for a combination of the gas and electric light plants of the city. About $200,000 will be expended immediately according to the report. F. A. Sharpe is the chief promoter.

CARLISLE, KY.—The plant of the Citizens' Electric Light Company, recently burned, will be rebuilt.

ASHLAND, KY.—The Ashland Iron & Mining Company will operate all its machinery by electric power, the motors for which will be furnished by the Stanley Electric Company, Pittsfield, Mass. An engine of 600 horse-power is to be furnished by the Atlas Engine Works, Indianapolis.

CENTERVILLE, MD.—D. S. Pindell, of Sault Ste. Marie, has secured a franchise for the construction of an electric light and gas plant at Centerville.

BALTIMORE, MD.—The new Consolidated Electric Light & Gas Company, of Baltimore, has made a bid of $57.49 per lamp for lighting Baltimore. The city is now paying $99.92 per lamp.

WORONOCO, MASS.—The Woronoco Paper Company is now running its entire mill by electric power generated at the new power-house. The equipment consists of two 200, two 100, one 75, one 50, three 30 and two 20-hp induction motors. The plant presents many new and interesting features in electrical installation, and is one of the best equipped in the United States.

CANAAN, MASS.—The Berkshire Power Company has concluded a deal for the purchase of the Sharon Electric Light & Power Company of Sharon. Possession of the business and property will take place on April 1. The Berkshire Company is erecting a large power plant on the Housatonic River, and power from this station will ultimately be used to operate the Sharon business.

DETROIT, MICH.—The Detroit Commercial Electric Light Company has been formed and will apply for a charter. It will petition City Council for a franchise. W. E. Fenwick, Morris M. Green and H. W. Wells are among the directors.

FOLEY, MINN.—Daniel Stimler, of Minneapolis, has petitioned the Village Council for a franchise for an electric light plant for Foley.

ST. CLOUD, MINN.—The Public Service Company, of St. Cloud, has organized and authorized an issue of bonds to the value of $230,000 for improvements in the electric light plant and street railway.

WARREN, MINN.—The matter of constructing a duplicate municipal electric light plant is in the hands of a committee which will procure an engineer, and ask for bids. W. Haney is superintendent of the plant.

HOUSTON, MISS.—It was voted, Feb. 28, to issue $13,500 bonds for the construction of water works and an electric light plant. J. M. Griffin is town clerk.

MOBERLY, MO.—The Moberly Gas & Electric Company proposes reorganizing and rebuilding its plant this spring. J. Green is president.

ST. LOUIS, MO.—At a meeting of the directors of the Laclede Gaslight Company, W. F. White, of New York, was elected a vice-president. Formerly the company had no New York representative who could sign its certificates and Mr. White was elected for that purpose.

TEKAMAH, NEB.—It was voted, March 7, to issue $10,000 bonds for the purchase or installation of an electric light plant. J. M. Crowell is city clerk.

ALMA, NEB.—Bids will be received about April 15 for the construction of water works and an electric light plant at a probable cost of $20,000. A. Billings is city clerk.

TEKAMAH, NEB.—The question of issuing $10,000 bonds to purchase the present electric light plant or install a new one and operate it in conjunction with the city water works, is under consideration.

BAYONNE, N. J., proposes to try a municipal electric light plant and to light the Hudson Boulevard.

COHOCTON, N. Y.—The question of constructing an electric light and power plant is under consideration here.

ONEIDA, N. Y.—The Madison County Gas & Electric Company, of Oneida, has secured the contract for lighting the streets with electricity for $6965.

BROOKLYN, N. Y.—The Mayor has approved the ordinance providing for an issue of corporate stock to the amount of $100,000 to place electrical conductors underground in Brooklyn Borough under the jurisdiction of the fire department.

NEW YORK, N. Y.—The board of directors of the Kings County Electric Light & Power Company and the Edison Electric Illuminating Company, of Brooklyn, at the annual meeting of the respective companies held recently, elected the following officers: President, A. N. Brady; vice-president, E. A. Leslie; secretary and treasurer, W. W. Freeman.

FREEPORT, L. I., N. Y.—The South Shore Gas Company, of Freeport, has been incorporated with a capital of $50,000, to supply gas and electricity in Freeport, Baldwin, Merrick, Bellmore, Seaford, Massapequa and Amityville. The directors are George MacDonald and Wilson Bell Waite, Jr., of New York City, and John Flanigan, of Wilkesbarre, Pa.

SANDY HILL, N. Y.—There is absolutely no truth, we learn, in the reports which have had wide circulation, to the effect that the Gas, Electric Light & Fuel Company, of Sandy Hill, N. Y., has been purchased by the Hudson River

Electric Company. The Sandy Hill Company is in a vigorous and prosperous condition, and it is stated that the owners have no intention of selling out.

PENN YAN, N. Y., has just put in operation its new municipal electric lighting plant. It consists of two Stanley alternators driven by two 225-hp Watertown engines, one unit being held as reserve. The boiler plant is of 150-hp. The 76 arc lights are of the Adams-Bagnall enclosed type alternating current. There are 10 miles of pole line and 50 miles of circuit. The plant cost about $35,000. The engineer in charge is Horace B. Sweet, of Utica.

CONCORD, N. H.—At the annual meeting of the Concord Light & Power Company these officers were elected: Directors, Benjamin A. Kimball, Randall Morgan, of Philadelphia; Dr. F. A. Stillings, Henry W. Stevens, Edson J. Hill, Alvin B. Cross, Frank P. Andrews; president, Benjamin A. Kimball; vice-president, Edson J. Hill; clerk, Frank P. Andrews; treasurer, Lewis Little; assistant treasurer, James Ball.

DALLAS, N. C.—It is proposed to construct an electric light plant at a cost of $3000. Dr. S. A. Wilkins is clerk of the town board.

GRAND FORKS, N. D.—The Council is considering the installation of a municipal plant for commercial lighting.

ARCANUM, OHIO.—The citizens have voted to issue $38,000 bonds for water works and an electric light plant.

ONTARIO, ORE.—Seymour H. Bell and Chas. H. Chance, of Sumpter, have secured a franchise for the construction of an electric light plant at Ontario.

BAKER CITY, ORE.—Halsey & Company, and the Cyrus Pierce Syndicate, of Philadelphia, has purchased the property of the Baker City Power & Light Company for $400,000. The transmission lines will be extended at once to other mining properties in the Sumpter District.

KUTZTOWN, PA.—The citizens have voted to issue $15,000 bonds for the construction of an electric light plant.

YORK, PA.—It is reported that when spring opens again work preliminary to the construction of an electric power plant on Susquehanna River, about 1½ miles below McCalls Ferry, will again be resumed.

DARLINGTON, S. C.—The new owners of the Darlington Light & Water Company propose enlarging the plant. They also propose installing a plant at Timmonsville.

NEWBERRY, S. C.—It is stated that Horace B. Parker, of Boston, Mass., will finance the enterprise which proposes developing water power at Parr Shoals on Broad River near Peak Station, between Newberry and Columbia.

COLLIERVILLE, TENN.—The citizens have voted to issue bonds for the construction of an electric light plant.

BRISTOL, TENN.—J. Edw. Durham, of Philadelphia, Pa., and Wm. B. Cutter, of Buffalo, N. Y., have applied for a franchise for an electric light plant.

McEWEN, TENN.—William McDonough, proprietor of the Dickson Machinery Repair Company, is making arrangements to put in an up-to-date electric light plant here.

LONEOAK, TEX.—W. L. Harrison is interested in the construction of an electric light plant.

HAMILTON, TEX.—The Hamilton Light & Ice Company has been organized here with a capital stock of $20,000. C. Schuwirth, of Dallas, is interested.

PAYSON, UTAH.—The citizens have voted to issue $12,000 bonds to improve the electric light plant.

STAUNTON, VA.—L. S. Randolph, Blacksburg, writes that bids will probably be received in the fall for the construction of a power plant at the Western State Hospital, to cost from $8000 to $15,000.

NORFOLK, VA.—The Norfolk Railway & Light Company has awarded to the Southern Construction Company the contract for installing a conduit system, in which all electric light wires south of Green Street will be placed. The probable cost of work is placed at $100,000.

NORTHFORK, W. VA.—The Elkhorn Light & Power Company, of Northfork, has been incorporated with a capital of $100,000. The company is also empowered to construct telephone and telegraph lines. The incorporators are J. J. Tierney, Elkhorn; L. H. Clark, of Kyle, and others.

FAIRMONT, W. VA.—The Manington Light & Power Company has been incorporated with a capital stock of $100,000 to construct and operate an electric railway between Fairmont and Manington. The incorporators are W. H. Furbee, J. M. Barrack, F. W. Bartlett, Geo. W. Bowers and L. S. Schwenck, all of Manington.

BLAINE, WASH.—The City Council has granted H. L. Jenkins a franchise for the construction of an electric light plant.

ROCKFORD, WASH.—W. F. Connor, of the Washington Water Power Company, of Spokane, is reported interested in the construction of an electric light plant at Rockford.

SPOKANE, WASH.—The Washington Power Company has re-elected the present directors. A special meeting of the company will be held April 24, to vote on the question of increasing the capital stock from $3,600,000 to $5,000,000.

MILWAUKEE, WIS.—The Union Light & Power Company has been incorporated with a capital of $5000. Chas. Tryon and I. B. Budd are the incorporators.

CARLSBAD, N. MEX.—Geo. Bruce, of Carlsbad, has secured the contract for constructing a dam in Pecos River for the Utilities Company, to be used in generating electricity for light and power purposes.

CALGARY, ALBERTA, N. W. TER.—Bids will be received until March 15 for installing a complete electric light plant. F. W. Thorold is engineer.

WESTMOUNT, QUE.—The Council has under consideration the construction of municipal water works and an electric light plant.

The Electric Railway.

HARTFORD, CONN.—The New York, New Haven & Hartford Railroad is to abandon the third-rail on its line between Hartford and Bristol. The line was laid some time ago for experimental purposes.

NEW HAVEN, CONN.—The New York, New Haven & Hartford Railroad Company, through its electric railway holding company, the Consolidated Railway Company, has negotiated the purchase of the Hartford Street Railway Company, Hartford, Conn.

ATHENS, GA.—An auxiliary steam plant is to be installed by the Athens Electric Street Railway Company to supplement the hydraulic plant at Mitchell's Bridge and Tallahassee Shoals. The equipment for the new plant is said to have been bought.

PARIS, ILL.—The City Council has granted a franchise to the Paris Traction Company to use the streets for railway purposes.

CHICAGO, ILL.—It is reported that the Chicago & Oak Park Elevated Railroad Company will construct a $500,000 power house.

CHICAGO, ILL.—It is reported that plans are being made by the Chicago City Railway Company for the building of a large new power house near the south branch of the river and north of Twenty-second Street.

CHICAGO, ILL.—The Chicago City Railway Company will probably let contracts for 200 new cars the latter part of March. The Chicago Union Traction Company is drawing up specifications for 60 new cars.

LOGANSPORT, IND.—The Logansport & South Bend Traction Company has increased its capital to $100,000.

LOGANSPORT, IND.—The Ft. Wayne & Wabash Valley Traction Company has decided to go into the electric lighting business. The power which its different plants develop, and the increased power which can be produced without material increase in expense, have caused the management to decide to extend the business.

INDIANAPOLIS, IND.—The Indianapolis & Chicago Air Line Traction Company has filed articles of incorporation with the Secretary of State. The company is capitalized at $1,000,000. The names of the incorporators are G. B. King, W. W. Taylor, H. S. Leonard, J. A. Shafer and John Feiger, of Indianapolis; C. J. Rauh, of Chalmers; C. F. Knowlton, of Pennville; J. J. Gipsen, W. H. Thornburg and George F. Rauft, Alexandria; A. J. Behymer and M. E. Harvey, of Elwood, and J. W. Alderman, of Chicago.

GRINNELL, IA.—The first meeting of the stockholders of the Grinnell Interurban Railway Company recently resulted in the election of the following directors: O. K. Cole, of the Grinnell Electric & Heating Company; H. W. Spaulding, B. J. Carney, T. J. Bray, G. H. McMurray, John Goodfellow and Dr. E. W. Clark. The company is only organized as yet for the purpose of making surveys, and investigating prospects. A line in the direction of Tama City is talked of.

LOUISVILLE, KY.—The present owners of the Henderson City Railway have secured franchises and rights of way for an electric railway from Evansville, Ind., to Henderson and Owensboro, Ky. Mr. H. W. Richardson, of this city, is interested.

LAKE CHARLES, LA.—Contracts have been closed with the Westinghouse Electric & Mfg. Company for the electrical equipment for the Lake Charles Street Railway.

NEW ORLEANS, LA.—The franchise for an electric street railway, to be operated in Jefferson Parish, from the Orleans Parish line to Gretna, has been sold to Messrs. Leigh Carroll and James Dinkins, of the Algiers and Gretna sections.

GULFPORT, LA.—The West Gulfport & Race Track Street Railway Company has been incorporated by Phil A. Dolan, J. R. Hill, J. R. Pratt, S. P. Moorman, E. S. Burrill, W. R. Bachellor, J. T. Richardson and P. H. M. Tippin. The capital stock is fixed at $25,000, with privilege to begin operations when $5000 has been paid in.

MANISTEE, MICH.—The Manistee, Filer City & East Lake Electric Railway has been sold by John Lawrence, master in chancery to Walter H. Trumbull, of Salem, Mass., who represents the holders of the first mortgage bonds. Mr. Lawrence's bid was $51,000.

GREENFIELD, MASS.—Stockholders of the Greenfield, Deerfield & Northampton, the Greenfield & Turners Falls and the Northampton Street Railway Companies have voted in favor of a project to consolidate under the name of the Connecticut Valley Street Railway Company with a capitalization of $490,000. The railroad commissioners will be asked to approve the consolidation.

AUBURN, N. Y.—The State Railroad Commission has granted the application of the Auburn & Northern Electric Railroad for permission to construct a road from Auburn to Port Byron, N. Y.

ALBANY, N. Y.—The New York, Auburn & Lansing Railroad Company has received permission from the State Board of Railroad Commissioners to issue $1,000,000 mortgage bonds. The company has a charter to construct and operate a road from Auburn to Ithaca.

GREENSBORO, N. C.—The stockholders of the Alamance Street Railway Company have elected the following-named officers: J. W. Menefee, president; John D. Twiggs, Jr., vice-president; F. L. Williamson, treasurer; James S. Thompson, secretary.

COLUMBUS, OHIO.—The Columbus Railway & Light Company is preparing to install a large storage battery station.

CLEVELAND, OHIO.—The Cleveland Electric Railway Company is preparing to install a large storage battery station on Harvard Street.

LORAIN, OHIO.—A syndicate, composed of stockholders of the Lake Shore Electric Railway Company, has purchased the Lorain Street Railway Company, with an interurban line to Elyria.

DELAWARE, OHIO.—The right of way between Delaware & Magnetic Springs, owned by the Union Electric Railway Company, of Camden, N. J., has been transferred to the Delaware & Magnetic Springs Railway Company.

FOSTORIA, OHIO.—The Toledo, Fostoria & Findlay Railway has secured the greater portion of the right of way required for its extension from Fostoria to Pemberville. By means of the Lake Erie, Bowling Green & Napoleon and the Lake Shore Electric Railway direct connection will be made for Toledo.

ZANESVILLE, OHIO.—The Zanesville, Cambridge & Northern Traction Company has elected the following officers: President, Frank McCormac, New Concord; secretary, S. H. Nicholas, Coshocton; chief engineer, W. A. Ginn, Columbus. The company will build from Zanesville to New Philadelphia with a spur line to Cambridge.

MANSFIELD, OHIO.—The Mansfield Railway, Light & Power Company, which is completely revamping its power plant, has placed an extensive order for the necessary machinery, including one 250-kw and two 530-kw Bullock generators, one 500-kw and one 600-kw railway generator, one 125-hp motor and one motor generator set. The contract goes to Allis-Chalmers Company, who will construct the apparatus at its electrical works in Cincinnati.

SHARPSVILLE, PA.—The City Council has granted a franchise to the Greenville Traction Company.

POTTSVILLE, PA.—The Tamaqua & Pottsville Electric Railroad has been granted a franchise to build two branches through the town of St. Clair.

SUBBURY, PA.—The Northumberland County Traction Company will extend the Lewisburg, Milton, Watsontown line from East Lewisburg to Northumberland via Montandon.

HUMMELSTOWN, PA.—The Hummelstown & Campbelltown Street Railway Company has arranged to issue bonds to the amount of $225,000 to provide for an extension this spring and summer of the line into Campbelltown, and thence prospectively to Bismarck. Mr. M. S. Herschey is president of the company.

MEMPHIS, TENN.—It is stated that a deal has just been closed in New York whereby the entire capital stock of the Memphis Street Railway Company has passed into the control of Isidore Newman & Sons and Ford, Bacon & Davis, of New York. Mr. George H. Davis, of the purchasers, has been elected president of the company.

AUSTIN, TEX.—The project of building an interurban electric railway between Austin and Fredericksburg is being considered by local capitalists. The distance is about 75 miles.

SAN ANGELO, TEX.—Edward Merrick and A. J. Morgan have taken the necessary preliminary steps looking to the construction and operation of an electric street railway system in San Angelo.

HOUSTON, TEX.—The Houston-Galveston Electric Railway Company which was recently organized with a capital stock of $1,350,000, to build an interurban electric railway between the two cities named, it is stated, has no connection whatever with the Houston-Galveston Interurban Railway Company organized some time ago to build a similar line.

NORFOLK, VA.—The Norfolk Railway & Light Company has awarded a contract of $100,000 for placing all of its electric lighting wires south of Queen Street underground.

RITZVILLE, WASH.—The name of the Adams County Electric Transit Company has been changed to Big Bend Traction Company. Officers were elected as follows: President, A. W. Turner; vice-president, P. R. Clark; treasurer, H. H. McMillan; secretary, W. W. King; assistant secretary, W. C. Graham, and general counsel, O. R. Holcomb.

MANITOWOC, WIS.—The Fox River Railway Company has been incorporated by Henry W. Beyersdorf, L. N. Bazlen and Fred Beyersdorf, to build an electric line in Manitowoc, Sheboygan and Ontagamie counties.

WAUSAU, WIS.—The Wisconsin River Traction & Power Company has been incorporated with a capital of $90,000. It is reported that this is the beginning of one of the largest interurban railway, water power and paper mill systems in the west. Water power at Trappe City, it is said, will be developed, the last Legislature having granted a franchise to erect a dam across the Wisconsin River at this point. The corporation is headed by Neal Brown, G. D. Jones and Carl Mathie.

SANTA FE, N. MEX.—The Rio Grande Valley Electric Railway Company has been incorporated to build an electric railway from El Paso, Tex., to the mining camp of Organ, a distance of 65 miles. The headquarters are at Las Cruces and the capital stock is $1,000,000.

New Industrial Companies.

THE TEL-ELECTRIC COMPANY, of Pittsfield, has been formed.

THE MONITOR ELECTRICAL SPEED RECORDER COMPANY, of Cambridge, Mass., has been formed with a capital of $5000: president, James H. Kendall; treasurer, George F. Kendall.

THE CADIZ ELECTRIC COMPANY, Cadiz, Ohio, $12,000 capital, has been incorporated by S. B. McGavran, J. V. Conner, E. W. Long, S. K. McLaughlin, R. Cunningham, M. Schreiber, G. D. McFadden.

THE OHIO VALLEY ELECTRICAL SUPPLY & CONSTRUCTION COMPANY, of Steubensville, Ohio has been formed with a capital of $50,000, by H. P. McGowan, John Kidd, O. G. Swords, W. A. Garber and M. S. Gillett.

THE MOTOR CAR SPECIALTY COMPANY has been formed at Trenton, N. J. The capital stock is placed at $70,000. Edward Lee, John O. Hart and George E. Dunn are the incorporators. The concern will manufacture motor car parts and, if local capital can be enlisted, a plant will be located here.

THE PORCELAIN ELECTRIC MANUFACTURING COMPANY, of Trenton, N. J., capitalized at $25,000, has been incorporated. The incorporators are Charles A. Secor, New York; William I. Peacock and Frederick R. Brace, of Trenton. The company is to manufacture and deal in electrical and porcelain goods.

THE EASTERN TELEGRAPH & STOCK COMPANY, of Kittery, Me., has been incorporated with a capital stock of $100,000, to deal in stocks, bonds, etc. The officers are: President, H. Mitchell, Kittery; treasurer, M. G. Mitchell, Kittery.

THE ELECTRICAL OZONE MACHINE COMPANY, of New York City, has been incorporated with a capital stock of $250,000. The names of the directors are W. C. Hughes and William Scully, Brooklyn, and G. P. Ferguson, New York.

THE NORTH SHORE ELECTRIC COMPANY, Chicago, Ill., has absorbed the Calumet Lighting Company, formerly the Calumet Gas & Electric Company. The purchase includes both the water and electric plants of the Calumet Company in Harvey and Chicago Heights.

THE EDGEWATER & HUDSON VIEW CONSTRUCTION & TRACTION COMPANY, of Hudson Heights, N. J., has been incorporated with a capital stock of $100,000. The incorporators are August Sieber, Hudson Heights; Thomas Kerrigan, New York City; Wm. M. Schultz, West Hoboken; Robert H. Sander, North Plainfield; Thos. F. Prosser, Guttenberg; Wm. Dahm, Chas. A. Seiber, North Bergen.

Legal.

CHICAGO TELEPHONE FIGHT.—Corporation Counsel Tolman has filed a petition for quo warranto proceedings against the Chicago Telephone Company to show why its charter should not be annulled because of the failure of the company to submit a report of its gross earnings for the last six months of 1904, its failure to pay the city 3 per cent. of its gross earnings, and its disinclination to compromise with the city regarding the charging of tolls within the city limits.

CLEVELAND LIGHTING LITIGATION.—At Cleveland, Ohio, on March 11, Judge Beacom, in Common Pleas Court, granted the petition of the Cleveland Electric Illuminating Company for a perpetual injunction restraining the City Council, Mayor Johnson, City Solicitor Baker, and the City of Cleveland from enforcing or attempting to enforce any order on the company to produce its books and papers at the bribery investigation of the Council. The books were wanted to prove the allegation that the Cleveland Electric Illuminating Company had contributed to the campaign fund of Republican members of the City Council and made direct payments of money to two Democratic members of the same body. The Council's investigation of these charges by Mayor Johnson was stopped, pending the decision by Judge Beacom. The court holds that the Council has no authority to try its members upon a charge of bribery or of "undue influence," and that if such charges are made, the proper trial tribunal is a judge and jury.

Educational.

LEHIGH UNIVERSITY.—The register of Lehigh University, South Bethlehem, Pa., just issued, copies of which may be had on application, shows the attendance of 630 students from 24 States and 8 foreign countries, the largest in the history of the institution. There are 56 in the teaching staff. 92 students are taking the course in electrical engineering. 13 four-year courses of instruction are offered at the University: the classical course, the Latin-scientific course, the courses in civil, mechanical, marine, metallurgical, mining, electrical and chemical engineering, analytical chemistry, geology, physics and electrometallurgy. A list of graduates of the University, with their present occupations, 1399 in number during the 39 years of its existence, indicates that this institution is exerting a marked influence on the industrial development of the United States and foreign countries. Provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

WORCESTER POLYTECHNIC INSTITUTE.—The thirty-fifth annual catalogue of the Worcester Polytechnic Institute has just appeared. It is a volume of 214 pages, giving full information in regard to entrance requirements, courses of study, equipment, etc., lists of alumni with their present occupation, and similar information. The present catalogue shows that the force of instruction consists of a faculty of 16 professors and assistant professors, and 21 instructors and assistants, beides many assistants in the Washburn shops. The student enrollment is the largest yet recorded, being 324. This includes 8 graduate students, 44 seniors, 51 juniors, 83 sophomores and 132 freshmen. The freshmen are not classified as to course of study, for they are not bound to elect their course until the end of the first year. The three upper classes are divided into 49 in the course in mechanical engineering, 35 in civil engineering, 22 in chemistry, 2 in general science and 78 in electrical engineering. Last June the Institute graduated 40 Bachelors of Science in the various courses. It conferred also the degree of Master of Science upon two candidates, the professional degree of Mechanical Engineer upon two, that of Electrical Engineer upon one and the degree of Doctor of Science for the first time upon one. These degrees are all conferred for work done, since the Institute confers no honorary degrees. The present catalogue for the first time specifies the courses offered for the professional degrees of Mechanical, Civil, Chemical and Electrical Engineer by the various departments. The list of graduates shows that 992 are now living and these living graduates as shown by the geographical register printed at the end of the book are to a very large extent engaged in occupations for which their Institute training fitted them.

Personal.

MR. CAMPBELL SCOTT.

MR. CAMPBELL SCOTT, who has just been appointed director of the Yonkers, N. Y., works of the Otis Elevator Company, was born at Hornsville, Ky., in 1869, and is the son of the late Dr. Preston B. Scott. He was well educated, finishing at the University School in Louisville, and under private tutorship. He entered business life in 1887 with the Gaynor Electric Company, of Louisville, manufacturers of the Gaynor fire alarm system, etc., and Southern agents for the old Thomson-Houston Company and the Sprague Electric Company. The work of the latter concern he gave special attention to, and contracted for many of the early electric railway systems. In 1889 he was made the Sprague representative, and on the absorption of the Sprague interests by the Edison General Electric Company, he became manager of the Louisville and Cincinnati offices in succession, building up at the latter place an enormous electrical business. This he repeated in Kentucky on returning for a time to manage the Louisville office. In the fall of 1891 he resigned to organize the Southern Engineering Company, of Louisville, which was incorporated in 1892 and which, under his presidency, did a great deal of construction. In 1894, he organized the Louisville Electrical Works, as sole proprietor, and manufactured the "Phœnix" transformer and other specialties. This business he sold out in 1896, and immediately after in 1897 he became Southern manager for the C. & C. Electric Company. A few months later he was transferred to the New York office, and was appointed salesmanager for the company. In 1899 he became secretary, general manager and a director, with entire charge of manufacturing and selling. Since that time he has made a special study of the economics of machinery manufacture, and his new position, one of great responsibility, finds him well qualified by a long, rich and unusual experience.

MR. W. J. CHALMERS has resigned as vice-president of the Allis-Chalmers Company. He has been succeeded by Mr. W. H. Whiteside.

MR. J. H. HALLBERG has accepted an appointment to the New York City Electric Lighting Commission, with which he will act in a general advisory capacity.

MR. FRANK K. JOHNSTON, an expert in patents, designs, trade marks, copyrights, etc., New York City, has removed his office from 99 Nassau St., to 170 Broadway.

DR. F. A. C. PERRINE, New York City is on a trip to Mexico in connection with a project to build another extensive power transmission system in that part of the world.

MR HENRY RUSTIN, who had to retire from his duties as chief of electrical and mechanical construction of the St. Louis Exposition owing to illness is again established in health and about to resume active work.

PROF. L. C. HERDT, assistant professor of electrical engineering at McGill University, Montreal, has been awarded the honorary title of officer d'academie, by the French Government, for services rendered in the field of art, science and literature.

MR. THOMAS W. WILSON has been appointed general manager of the International Railway Company, of Buffalo. He is 32 years of age and was graduated from Lehigh University in 1894. His promotion to the general managership followed the resignation of Mr. Thomas E. Mitten.

MR. GEORGE W. PIERCE, superintendent of the Stamford Street Railway Company, of Stamford, Conn., has been appointed general manager of the New York & Stamford Railway Company and the Greenwich Tramway Company, which have just been formally transferred to the Consolidated Railway Company, representing the New York, New Haven & Hartford Railroad.

MR. A. L. ROGERS, who has acted for some time past as manager of the New York office of the Stirling Company, has been appointed assistant to President Talbot, of the Platt Iron Works Company (formerly the Stilwell-Bierce & Smith-Vaile Company), of Dayton, Ohio. Mr. Rogers has already taken up his new position.

MR. WALTER P. PHILLIPS, a well-known newspaper man, and inventor of a system of steno-telegraphy, is at work on a history of the telegraph, telephone and electric light in America, which he expects to have ready in a year or two. Mr. Phillips is a close observer of events, and through his familiarity with the above-named lines of development his book will, no doubt, be a valuable addition to the literature on the subject.

MR. R. R. KELLY, assistant professor in the department of engineering at the University of South Dakota, Vermillion, S. D., is resigning in order to join the staff of the Symms & Powers Company, heating and ventilating engineers, of Sioux Falls, S. D. He will have charge of its engineering department. The company in addition to heating and ventilation will take up power plant and transmission work in its various branches. Mr. Kelly is a mechanical engineering graduate of Cornell University, 1901.

MR. A. E. WINCHESTER, manager of the municipal electric lighting plant at South Norwalk, Conn., informs us that they are adding about 200-kw to the capacity of the plant this summer, bringing it up to about 1000-hp. The commissioners, with an eye to the future, have recently bought some dock property at the center of distribution. Current is being sold down to 5 and 3 cents per kw-hour and over 40 factories are being run.

MR. E. M. FRASER has arrived in San Francisco from New York and is organizing a company for the purpose of manufacturing and applying to hydraulic elevators a radically new invention for regulating the amount of water used. By the new differential system the consumption of water, and consequently of power, is directly in proportion to the load carried. Mr. Fraser is well known as the inventor of the Fraser Electric Elevator System, now used by the Otis Company.

MR. CHAS. D. KNIGHT has been appointed chief engineer of the American Electric & Controller Company 12 Dey St., New York. Mr. Knight was formerly connected with the engineering departments of the General Electric Company, the National El-ctric Company, and the Cutler-Hammer Manufacturing Company. Under his supervision the American Electric & Controller Company will manufacture in addition to the "Rheocrat," a complete line of alternating and direct-current controllers, starters, automatic switches, solenoids, etc.

MR. W. K. PALMER.—A recent article in these pages, March 4, illustrated and described a compact switchboard at Kansas City. This article omitted to state the fact that Mr. W. K. Palmer, M. E., the well-known consulting and electrical engineer of that city, was the designer of this board, furnishing the detail drawings and specifications upon which it was carried out. This board is one of the most interesting and creditable of its type installed of late years in the southwest, and we are glad to take this opportunity of giving Mr. Palmer the credit to which he is entitled.

MR. GARDINER C. SIMS has become the general manager of the Marine Engine & Machine Company, of Harrison, N. J., and 80 Broadway, New York. The company will build Armington & Sims engines, in addition to its other products, to meet the requirements of the market. The original and constituent characteristics of the Armington & Sims design are still the fundamental features of the engine, which has been steadily improved in detail as necessitated by modern steam practice, since the introduction of the engine in 1872. The present patterns are all new having been reproduced and perfected by Mr. Sims since the cessation of his services during the Spanish-American war. Mr. Sims is widely and favorably known in the electrical field, where his good pioneer work did so much to ensure the success of incandescent lighting 25 years ago.

MR. G. MARCONI.—A cable dispatch from London of March 11 says: "Mr. Marconi's flat, in Piccadilly, in view of his forthcoming marriage, is stacked with cases and boxes containing wedding presents from his admirers and friends in all parts of the world. The Hon. Beatrice O'Brien is a lucky bride-elect, gifts of every kind having been showered upon her, jewels of great price, costly furs, valuable old silver, historic lace, pictures and old furniture and every conceivable object that the heart of woman could desire. Her fiancé's presents are lavish, and include a full length coat of Russian sables and a collection of jewelry, which includes a tiara and collar as well as corsage ornaments. The Marconi Company gave a magnificent set of sables to match the coat. The employees on the different Marconi stations will present a chest of plate."

News of the Trade.

CHANGE OF NAME.—The corporate name of the Arnold Electric Power Station Company, Chicago, was, on March 15, changed to The Arnold Company.

THE ELECTRIC APPLIANCE COMPANY, Chicago, says that the Packard lamp lives a useful life up to 600 or 800 hours. At the end of that time if the lamp has not died a natural death, the company advocates the use of chloroform—removal from the circuit.

ALLIS-CHALMERS COMPANY, of Milwaukee, Wis., will be represented hereafter in West Australia by Mr. F. R. Perrot, and in New Zealand by the firm of John Chambers & Son, Ltd. Mr. Perrot's headquarters are at Perth, West Australia, and those of John Chambers & Son, Ltd., are at Auckland.

MR. GEORGE W. CONOVER, of Chicago, Ill., has succeeded to the business formerly conducted in the name of George W. Conover & Company. Mr. Edward W. Hammer, who was the other member of the company, has transferred all of his interests to Mr. Conover and withdrawn from the partnership in order to devote his entire time to his other business interests.

MECHANICAL FORCED DRAUGHT.—The boiler plant of the Atlantic Product Company, Atlantic City, N. J., has recently been equipped by the B. F. Sturtevant Company with a mechanical forced draft equipment for six 150-hp boilers. The fan, which is driven by a horizontal engine, is so arranged as to discharge the air through an underground duct into the hollow bridge wall from which it escapes to the ash pits through special dampers under the control of the fireman. The pressure thus created within the ash pit is uniform over the grates and conducive to a greatly increased rate of combustion.

AIR COOLING AROUND FURNACES.—Much recent legislation looking to the comfort of employees has had to do with the maintenance of proper temperature and purity of the air in manufacturing plants. The nature of the work in connection with the manufacture of iron and products therefrom especially calls for devices which shall not only add to the comfort of the workmen, but at the same time increase their output. With this object in view, the tube works department of the Reading Iron Company, Reading, Pa., has recently made a special application of two large electric fans manufactured by the B. F. Sturtevant Company, of Boston, Mass., for supplying blast for cooling around the furnaces. Similar devices are being adopted in many of the large plants where work of this character is carried on.

GAS & ELECTRIC DEVELOPMENT COMPANY.—This concern has been established to handle, examine, consolidate, report on and otherwise interest itself in gas, electric light, power and street railway plants. It has offices at 1328 Chestnut Street, Philadelphia, and 82 Beaver Street, New York. Where conditions are favorable, the company is ready to build plants and take first mortgage bonds. The officers are: President, Harry C. Case; vice-president and engineer, A. B. Beadle; secretary and treasurer, W. W. Levering; superintendent of construction, S. S. Ingham; counsel, Roberts & Measey. Directors:

Harry C. Case, of the Lambertville (N. J.) Heat, Light & Power Company, Florence (S. C.) Light & Power Company, Downingtown (Pa.) Gas Company, Georgetown (S. C.) Electric Company; A. B. Beadle, engineer for the Easton (Pa.) Gas & Electric Company, Frederick (Md.) Gas & Electric Company; Harvey L. Elkins, Colonial Trust Company; Wm. H. Houston, Tacony Trust Company; Wm. Maul Measey, attorney at law; Owen J. Roberts, assistant district attorney, Philadelphia; M. N. Willets, Jr., Corn Exchange National Bank; and W. W. Levering.

THE STANDARD UNDERGROUND CABLE COMPANY announces that, on account of the general growth of its business on the Coast, it has decided to discontinue all agency arrangements for the sale of its products there, and on April 1 will open its new offices in the Rialto Building, San Francisco, with Mr. A. B. Saurman as manager for the Pacific Coast teritory, which includes Washington, Oregon, Idaho, California, Nevada, Arizona, British Columbia, Alaska and the Hawaian Islands. Mr. Saurman has in turn been connected with the Standard Underground Cable Company in both construction and sales departments at Philadelphia and New York, and was later for several years manager of the Boston office; while for the past two years his position has been that of manager of the Pacific Coast sales department. The Standard Underground Cable Company expects to make early announcements of location and pensonnel of sub-sales offices at Los Angeles and Portland. It also reports that its factory at Oakland, Cal. (the only factory west of the Mississippi equipped with lead presses for cable work), has been unsusally busy during the past six months, and that the future on the Coast points to its continued activity.

Trade Publications.

PRODUCER GAS.—The latest trade publication of R. D. Wood & Company, Philadelphia, Pa., is devoted principally to the subject of producer gas power plants, the details of which are shown in several illustrations. Another catalogue of the same company describes various types of high grade centrifugal pumping machinery.

WHEN USING THE TELEPHONE.—A booklet devoted to time-saving methods and devices for offices has been given the above title by Mr. J. A. Rawson, Jr., of 130 Pearl St., New York, who uses its pages to present in an attractive and entertaining manner the advantages of various attachments for office desks, such as telephone brackets, writing tablets and swinging tables.

PROTECTIVE DEVICES.—The Appleton Electric Company, Chicago, has just issued a price-list of its extensive line of electric protective devices, including fuse wire, fuse strip, fuse links, enclosed fuses, lightning arresters, telephone distributing boards, test connectors, wire joints, metal cable hangers, etc. The different devices are illustrated and the variety of these goods is quite remarkable.

ISOLATED ELECTRIC LIGHT EQUIPMENTS.—The Richardson Engineering Company, of Hartford, Conn., in a recent circular shows a number of complete electric light outfits for launches, yachts, houseboats, houses, hotels, factories, etc. This company has an exhibit at the Motor Boat and Sportsmen's Show now being held in Madison Square Garden, New York, of some of its complete electric light outfits.

WALRATH GAS AND GASOLINE ENGINES.—The latest catalogue of the the Marinette Gas Engine Company is a 48-page oblong pamphlet containing more than a score of excellent half-tone illustrations of various types of Walrath gas engines, together with some full-page illustrations of the extensive shops at Marinette in which this engine is made. A number of direct-connected generating sets are shown and a view is given of an interesting 30-hp portable gas-driven electric lighting plant.

THE SAME OLD THINGS, also some new ones, is the title given by the American Electric Fuse Company to its catalogue devoted to fuses and holders. The catalogue is well illustrated, the descriptive matter being brief and to the point while humorously presented. Thus lightning arresters are referred to as electric policemen. It is stated that a good fuse is a rare article when the company's name isn't on the box. In the bulletin at hand the devices dealt with are intended exclusively for telephone circuits.

INDUSTRIAL RAILWAYS.—Pamphlet 51 of the C. W. Hunt Company, has for its subject "Industrial Railways," in which all the details of track are illustrated and described and views given of different types of standard cars, as well as of an electric locomotive for this service. A number of pages contain illustrations of industrial railways installed by the Hunt Company, and the final pages include numerous illustrations of special cars made for various kinds of industrial transportation service.

"THE SPIRIT OF THE TELEPHONE."—The Controller Company of America, of Chicago and Sandusky, Ohio, has prepared a new calendar entitled the "Spirit of the Telephone," prepared by Mr. F. F. Sapp, as to design, and the drawing being made by Mr. R. W. Hirchert, a well-known Cleveland artist. The Controller Company has furnished these to the Sandusky Telephone Company for distribution to its customers. The design shows a female figure of graceful contour floating above the world of wires, a telephone in one hand and another telephone at her ear.

FLANGE JOINT GASKETS.—The history of flange joint packing has been, of necessity, closely identified with and influenced by that of all steam service. As the temperatures and pressures have increased, the earlier forms of flange gaskets have become less and less efficient, necessitating continual improvements to meet the severity of modern requirements. The advantages of asbestos for this purpose are described in a pamphlet "Flange Joint Gaskets" issued by H. W. Johns-Manville Company, 100 William Street, New York. The pamphlet is well printed and illustrated and contains a very complete list of sizes and prices.

WESTINGHOUSE REPRINTS.—A useful series of publications issued by the Westinghouse Elec. & Mfg. Company consists of reprints of papers and articles having for their subjects matters of prime importance to users of electrical apparatus. The latest of these reprints consists of three papers read before the 1904 meeting of the Ohio Electric Light Association. The titles of these are as follows: "Notes on Incandescent Street Lighting," by A. V. Randall; "Points for Consideration When Purchasing Series Alternating-Current Arc Lamps," by G. Brewer Griffin; "Instrument Equipment of a Testing Department," by F. Conrad.

WESCO SUPPLY COMPANY, St. Louis, has just issued Bulletin No. 61, dealing with the express type switchboard for small exchanges and combination wall telephone and switchboard with various keys, jacks and drops for telephone exchanges. The "Wesco" express type switchboards are supplied in unit sections. each for 100 lines. They are constructed so that further growth can be provided for by installing additional units without disturbing the previous equipments. Bulletin No. 62 is devoted to the equipment belonging to the subscribers' end of the telephone system, and gives a descriptive price-list of series and bridging telephones, transmitters, receivers and magneto-generators.

HANDLING OF COAL AND ASHES.—The Jeffrey Manufacturing Company, Columbus, Ohio, in Bulletin A describes and illustrates the coal and ashes distribution plant of the Scioto Valley Traction Company, in its power plant at Reese's Station, Ohio. The description of the plant and its operation is very lucid and should be of extreme interest to all progressive station managers. In this particular instance the cost of unloading and distributing coal, with labor at 15 cents an hour and current at 2 cents per kw-hour is 1 cent per ton for unloading and placing directly in the bin; unloading from car and placing in stock pile, 75 cents; taking ashes from pit and placing them into car, 8 cents per ton.

PAWLING & HARNISCHFEGER, Milwaukee, Wis., in a well illustrated bulletin, designated as No. 16, describe traveling electric hoists which are built in a two-motor type and a one-motor type for 110, 220 and 500 volts direct-current circuits. These machines vary in design from an elaboration of a hand hoist by the addition of electric power equipment to the most complete traveling crane capable of handling a finished steam locomotive without assistance. With each of the simpler hoists are furnished a load brake, a motor brake and a limit switch to provide the same factor of safety as is given to the traveling cranes. The bulletin is well illustrated, twelve different types of hoists being shown in actual service.

MECHANICAL STOKERS.—The Westinghouse Machine Company has put forth a beautifully executed pamphlet devoted to the Roney mechanical stoker, which is shown in minute detail as applied to various types of boilers. To illustrate the advantages of mechanical over manual stoking, a pair of steam pressure diagrams are given showing the considerable variation of pressure with hand firing and the remarkable constancy of pressure on the same boilers when equipped with the Roney stoker. The latter part of the book contains illustrations of important boiler installations employing the Roney stoker. A note in this section gives the information that during the past twenty years no less than a million horse-power of boilers have been equipped with the Roney mechanical stoker.

THORDARSON EXPERIMENTAL APPARATUS.—C. H. Thordarson, 153 South Jefferson Street, Chicago, in an exceedingly attractive booklet just issued, shows by a series of more than 50 illustrations, a variety of alternating current experiments which can be performed by the use of his experimental apparatus designed for laboratories and schools. Many who visited the Louisiana Purchase Exposition at St. Louis were fortunate enough to see some of these experiments performed by Mr. Thordarson at his exhibit in the palace of Electricity, and to these the illustrations and explanations given in the booklet will be especially interesting. Among the illustrations are five reproductions of discharges made with the 1,000,000-volt, 100-kw transformer built by Mr. Thordarson for the experimental laboratory of Purdue University.

"COMPRESSED FACTS ABOUT COMPRESSED AIR" is the title of a booklet by the Clayton Air Compressor Works, of 114 Liberty Street, New York City, giving a resumé of the points to be considered in buying an air compressor of medium capacity. After an introductory quotation from Andrew Carnegie, that "A small saving in each process means fortune," brief chapters are devoted to the following topics: "Economy of Compressed Air," "Features of a Money-Saving Air Compressor," "How These Features are Combined in a Good and Medium-Priced Machine," "Method of Driving Air Compressors," and "Some of the Uses of Compressed Air." It is worthy of note that under the last are enumerated 139 distinct applications of compressed air and the list is by no means exhaustive. Illustrations showing some type of compressor or part thereof adorn every page and the pamphlet is printed on a high grade of India tint paper and bound in blue and gold. It contains 32 pages and is standard in size, measuring 3½x6 inches.

ALLIS-CHALMERS COMPANY, Milwaukee, Wis., devotes catalogue No. 120 to Reynolds-Corliss engines and direct-connected air compressors. As a result of a large number of experiments, the following figures are given concerning the economy of various engines. The steam consumption of single-cylinder, non-condensing engines may be stated as 24 to 26 pounds per hp-hour under normal conditions. The same engine operating condensing requires 19 to 21 pounds, which figure also holds for compound non-condensing engines. Compound condensing engines take 12.5 to 15 pounds and the triple expansin engines 11 to 13 pounds of steam per hp-hour. It is stated that for ordinary pressure the economy of quadruple-expansion engines is about the same as that of the triple-expansion machines, and that their use is advisable only when extremely high-pressures are employed, or where, for mechanical reasons, a four-cylinder machine is desirable. In the power houses of the electric railways of New York city there are at present 28 Reynolds-Corliss engines with an aggregate rating of more than 261,000 horse-power.

AMERICAN ELECTRIC FUSE CO., Chicago and New York, has issued a bulletin illustrating and describing self-soldering, self-repairing and self-restoring heat-coil protectors manufactured under the patents of Charles A. Rolfe and William Kaisling. The self-soldering heat-coil is especially interesting. It consists of a hollow metal spool into which a short, straight pin is fastened by soft solder. The pin projects farther from one end than from the other. When the coil is operated, the solder melts and the pin is forced to the other extreme position. The solder, cooling when the coil is cut out of the circuit, refastens the pin in place. The only difference in the coil is that the pin now projects from the inner instead of the outer end. When reversed in the containing springs, the inner terminal becomes the outer, and the coil is again ready for use. Only a moment is required to replace an operated coil in operating position.

NEWTON MACHINE TOOL WORKS, Philadelphia, Pa., has issued catalogue No. 40, illustrating a number of different designs of extra heavy vertical milling machines, both belt and motor driven, which have been made very rigid and powerful to meet the demands of the locomotive and railroad machine shops for which they are specially adapted. Milling machine No. 3 is fitted with a self-contained crane, and arranged for direct drive by variable-speed motor. The motor is mounted on an extension bracket placed at the side of the machine and drives a 5-step cone for giving the large range of speed desired. Among the numerous illustrations contained in the catalogue is one showing a duplex rotary planing machine for the operation of which are used two variable speed, direct-current motors connected through worm gearing to the revolving cutters. No belts of any kind are used on this machine. Each planing head is entirely self-contained, the driving motor being rigidly attached thereto.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED MARCH 7, 1905.

[Conducted by Rosenbaum & Stockbridge, Patent Atty's, 140 Nassau St., N. Y.]

784,022. ELECTRIC SWITCH; Charles B. Askew, Chicago, Ill. App. filed May 11, 1904. A metal ball contained in an elongated box having a zigzag passage, moves tardily from one end to the other when the box is tilted, to make contact with terminals located in either end of the box.

784,024. DYNAMO ELECTRIC MASSAGE INSTRUMENT; Albert Barrett and William Condon, Kansas City, Mo. App. filed July 5. 1904. The machine is in two parts, a handle and a rotary portion on the end of a shaft projecting from the handle; the handle contains a magneto of which it forms one terminal while the other is formed by the rotary part.

784,032. LAMINATED CORE FOR DYNAMO ELECTRIC MACHINES; James Burke, New York, N. Y. App. filed March 9, 1904. The laminations are held clamped together by a collar on the shaft which is forced into a groove thereof and bears against the end lamination.

784,038. AUTOMATIC SELF-DROPPING TROLLEY POLE; John Deland, Terre Haute, Ind. App. filed Sept. 5, 1903. Details.

784,052. ELECTROMAGNETIC DEVICE; William Kaisling, Chicago, Ill. App. filed Oct. 17, 1901.

784,056. ELECTRIC MOTOR; Waldo A. Layman, St. Louis, Mo. App. filed Dec. 28, 1903. (See Current News and Notes.)

784,064. ELECTRICALLY OPERATED LOCKING MECHANISM; John Nordenberg, Canon City, Col. App. filed Sept. 16, 1904. A number of locks such as those on prison cell doors, are connected in series and with a plurality of circuits in such manner that the locks can be selectively operated.

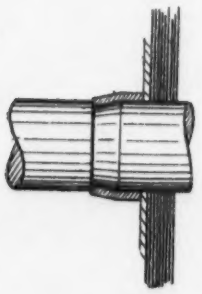
784,071. ELECTRIC LIGHTING APPARATUS FOR RAILWAY CARS; Williard F. Richards, Buffalo, and William A. Turbayne, Lancaster, N. Y. App. filed April 9, 1904. Details of construction of a framework for supporting a dynamo and motor especially adapted for train lighting.

784,082. RESONATOR; Edward F. Swigert, Lima, Ohio. App. filed May 2, 1904. A megaphone is attached to a box containing a telegraph sounder.

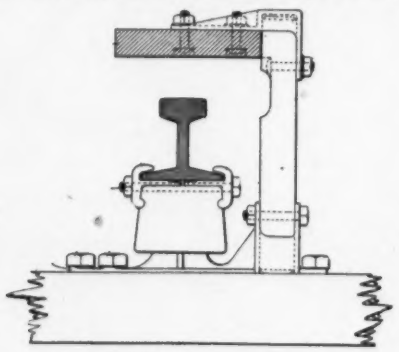
784,088. TELEPHONE SYSTEM; William D. Watkins, San Jose, Cal. App. filed March 11, 1902.

784,102. BRUSH HOLDER FOR DYNAMO ELECTRIC MACHINES; James Burke, New York, N. Y. App. filed May 3, 1904. A sheet metal holder pivoted at one end and having the brush at the other, with a spring arranged to be connected at various points along the length of the holder to alter the tension.

784,103. DYNAMO ELECTRIC MACHINE; James Burke, New York, N. Y. App. filed July 18, 1904. The field frame is in the shape of the letter U, inverted, the frame encompassing the poles and the coils thereon, to which access may be obtained through the open bottom.



784,032.—Laminated Core for Dynamo Electric Machines.



784,238.—Electrical Rail Guard.

784,175. AUTOMATIC TELEPHONE REPEATER; Emory Parsons, Chicago, Ill. App. filed Feb. 16, 1903.

784,186. THERMOSTAT; John E. Shepherd, Chicago, Ill. App. filed April 25, 1904. Details.

784,227. SEARCH-LIGHT FOR REVOLVERS OR OTHER FIREARMS; Byron C. Riblet, Spokane, Wash. App. filed Aug. 1, 1904. (See Current News and Notes.)

784,237. ELECTRICAL RAIL GUARD; Lewis B. Stillwell, Lakewood, N. J., and Frederick R. Slater, Yonkers, N. Y. App. filed Sept. 16, 1904. Relates to the construction of supports for a horizontal board placed above the third rail.

784,238. ELECTRICAL RAIL GUARD; Lewis B. Stillwell, Lakewood, N. J., and Frederick R. Slater, Yonkers, N. Y. App. filed Sept. 16, 1904. The bases for the guard and insulator are formed of a single casting, the guard being a horizontal board supported above the third rail.

784,250. LOCOMOTIVE CAB SIGNALING DEVICE; John W. Clark, Wyoming, Del. App. filed Jan. 4, 1905. Details.

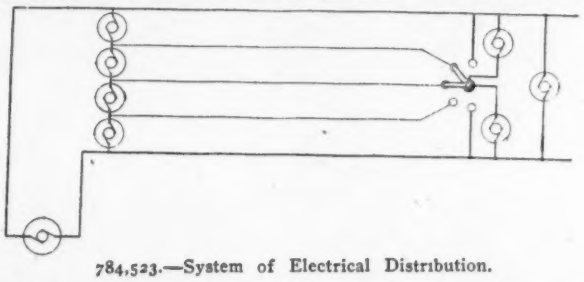
784,292. DIRECT-LINE CIRCUIT AND SWITCHING MECHANISM FOR TELEPHONE SYSTEMS; Albert K. Andriano, San Francisco, Cal., and Hermann Herbstritt, New York, N. Y. App. filed Nov. 21, 1903.

784,303. THIRD RAIL ELECTRIC RAILWAY SYSTEM; Thomas J. Casey and Fred H. Pickles, New York, N. Y. App. filed Aug. 11, 1904. The contact surface of the rail is vertical and facing the car; the guard is a hinged board projecting over the rail and having insulating blocks on the side which rests against the rail.

784,308. ELECTRIC MOTOR; George Dengler and Ida W. Schmidt, Detroit, Mich. App. filed Sept. 12, 1904. The cranks of a crank-shaft are connected to the cores of two solenoids, and switches for switching the current from one solenoid to another are actuated by another pair of cranks.

784,328. SYSTEM OF ELECTRICAL DISTRIBUTION; Frank Hoffman, Chicago, Ill. App. filed May 21, 1903. The method consists in maintaining three or more circuits of equal potential and connecting the armature terminals of a motor with different pairs of conductors on said circuits, so that all circuits which are simultaneously in operation carry substantially equal loads.

784,357. CIRCUIT CONTROLLER FOR ELECTRIC RAILWAY SIGNALS; Harry B. Snell, Jackson, Mich. App. filed April 15, 1904. Two contact plates are connected to but insulated from the trolley wire and



784,523.—System of Electrical Distribution.

used in connection with a switching apparatus of such character that either one of two devices will be actuated, depending upon the direction of movement of the vehicle.

784,387. ELECTRIC METER; Frederick Darlington, Great Barrington, Mass. App. filed Oct. 13, 1904. The driving force is conveyed directly to the retarding force, which may be a magnetic brake, without the use of a brush or other friction device, tending to destroy the accuracy of the meter. The energy necessary to make the electrical contact is supplied by a separate source of power.

784,388. APPARATUS FOR ELECTRICAL SIGNALING; Louis Despradels, Paris, France. App. filed Nov. 19, 1902. The essential feature of this instrument is a circular row of push-contacts which can be selectively pushed into operative position to be engaged by a rotating arm.

784,393. COMMUTATOR; Gustav Grabosch, Berlin, Germany. App. filed July 30, 1904. The commutator comprises a series of segment rings made of alternate blocks of metal and insulation, those in each ring being double the length of those in the preceding ring. The device is used in signaling of various kinds.

784,438. CURLING IRON; George F. Shields, Kern, Cal. App. filed Oct. 19, 1904. A glass tube containing an electric heater and having a handle through which the conducting wires lead.

784,447. MEANS FOR MAINTAINING SYNCHRONISM IN ELECTRIC MOTORS; Paul Thomas, Charlottenburg, near Berlin, Germany. App. filed March 7, 1903. (See Current News and Notes.)

784,448. TROLLEY; John H. Thompson, Charleston, W. Va. App. filed Aug. 4, 1904. Details.

784,454. ELECTRIC HEATER FOR OIL OR GAS WELLS; Fred B. Waring, Lima, Ohio. App. filed April 22, 1904. The heater comprises a series of tubes in which the heating coils are suitably centered, the tubes being supported by heads at each end in which the connections are made.

784,456. ELECTROMAGNET AND ARMATURE; Joseph Weber, Brooklyn, N. Y. App. filed May 1, 1900. A special arrangement of armature and magnet adapted for the operation of the keys of a musical instrument.

784,457. ELECTRICAL ATTACHMENT FOR MUSICAL INSTRUMENTS; Joseph Weber, Brooklyn, N. Y. App. filed Aug. 19, 1904. Each key has an upright projection carrying the armature for the magnet which actuates it.

784,464. MEANS FOR PROTECTING ELECTRIC CABLES AGAINST EXCESS PRESSURE; Georg Zapf, Cologne-Nippes, Germany. App. filed March 24, 1904. (See Current News and Notes.)

784,498. AUTOMATIC TELEPHONE EXCHANGE SYSTEM; John K. Norstrom and Henry M. Graif, Chicago, Ill. App. filed May 18, 1903. (See page —.)

784,502. MAGNETIC ORE SEPARATOR; Lewis G. Rowand, Camden, N. J. App. filed Feb. 28, 1898. A belt for conveying the ore passes between the pole pieces of a magnet and in closer relation to one pole than the other.

784,508. ELECTRICALLY ACTUATED PIANO; Joseph Weber, Brooklyn, N. Y. App. filed Aug. 19, 1904. The magnets are arranged directly above the keys and in a staggered relation so that magnets of a given size can be supported in a comparatively small space.

784,521. COMMUTATOR FOR ELECTRIC MACHINES AND PROCESS OF MAKING SAME; Fritz A. Feldkamp, Newark, N. J. App. filed April 16, 1901. The segments of the commutator are electrolytically deposited between wings formed on a hub of insulating material.

784,523. SYSTEM OF ELECTRICAL DISTRIBUTION; Frank Hoffman, Chicago, Ill. App. filed Aug. 13, 1903. Three or more electric circuits of equal potential and a switch for connecting the motor between different pairs of the conductors.